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Handling Coal in the Victor Plant

LOCOMOTIVE CRANE WITH GRAB BUCKET, PIVOTED BUCKET CARRIERS AND TRAVELING WEIGHING HOPPER FORM PART OF UNUSUALLY COMPLETE SYSTEM FOR HANDLING COAL AND ASHES IN THE PLANT OF THE VICTOR TALKING MACHINE CO. BY HENRY J. EDSALL*

EIGHTEEN YEARS AGO the plant of the Victor Talking Machine Co. consisted of one small building and the force of workmen included about a dozen men.

Today there are over 20 buildings, most of them very large and of the most modern design, and the employes number about 6000. It is one of the most remarkable growths on record and is a striking example of the results of business genius, in the development of the organization and policies of the company, as well as of inventive genius and engineering ability in the perfecting of the product and the manufacturing methods.

The plant is located in Camden, N. J., directly across the Delaware River from Philadelphia, and some of the property borders on the river. When, therefore, a new power house was decided upon, the location naturally selected for it was the river front property where the coal could be handled directly from boats and where the supply of condensing water is unlimited.

As a matter of fact this property was already used for unloading and storing coal, which was brought there in barges and unloaded with a floating, locomotive crane type of unloader equipped with an automatic grab bucket. The coal used in the old boiler room is small anthracite and the firing is done by hand. This coal was piled up on the wharf by the unloader, then, when needed, loaded, with the aid of a portable wagon loader, into an automobile truck, and taken to the vaults under the sidewalk at the old boiler room, which is 2 or 3 squares from the wharf.

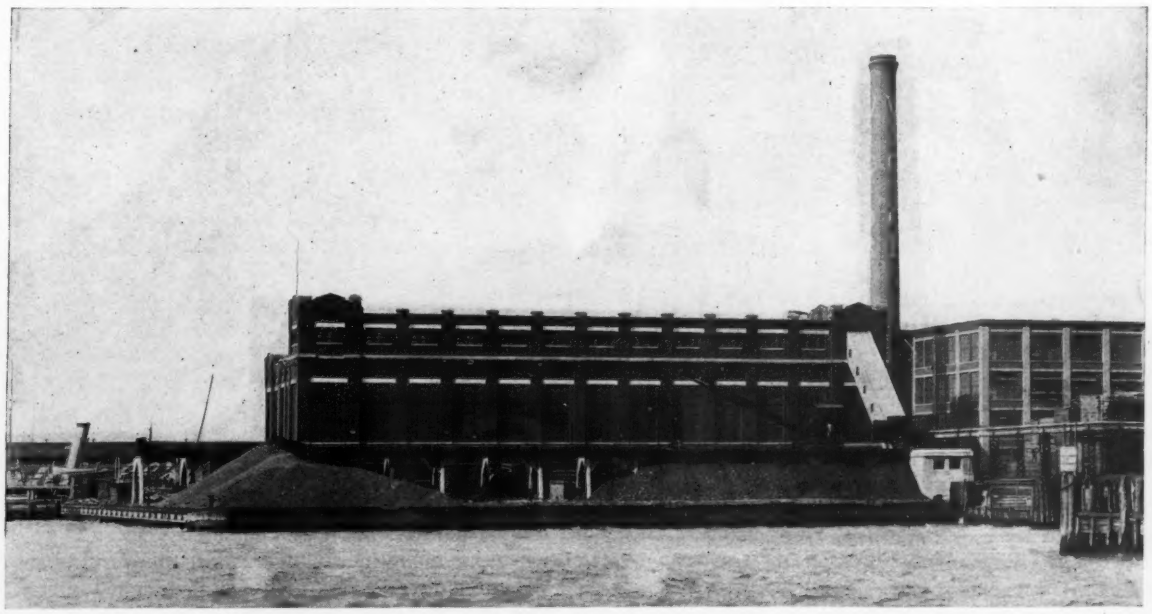


FIG. 1. GENERAL VIEW OF POWER HOUSE AND RESERVE COAL STORAGE

*Engineer with Link-Belt Company.

In the general re-arrangement of the wharf property in connection with the new power house, one of the most important things to be decided upon was the arrangement of the coal and ashes handling equipment, including a coal storage in the boiler room tributary to the stokers, and a reserve storage outside on the wharf to supply not only the new power house, but also to keep up the supply for the old boiler room.

The wharf property is about 275 ft. wide with the water front on one side and Cooper St. on the other side, and from the bulkhead line back to Delaware Ave., it is about 1000 ft. long. The part of the property nearest to Delaware Ave. is used for lumber storage, for one of the buildings connected with the record making department, and for one or two other purposes. It was decided, therefore, to locate the new power house on the north side of the wharf along Cooper St., and about 75 ft. back from the bulkhead line, but to unload the coal at the front of the wharf and transfer it back to the power house or deliver it to a storage pile extending from the front of the wharf back towards Delaware Ave.

Unloading of the coal from the barges is accomplished by means of a locomotive crane equipped with a self-filling grab bucket. The crane is a standard 15-ton, 4-wheel steam crane with a 50-ft. boom and a 1½-yd. bucket, but instead of using a track of standard gage, the rails are set with a gage of 10 ft. to give greater stability to the crane and allow the bucket to go down between the rails. The track is elevated about 19 ft. above the wharf level and each rail is supported on steel girder beams spanning between concrete piers spaced at intervals of 16½ ft. Running on this same track there is a weighing car holding 20 tons of coal. This car is on the opposite side of the crane from the river front and is connected to the crane with a draw bar platform. The coal is taken out of the barges with the bucket and deposited in the weighing car. When the car is full it is weighed and then the crane pushes it along the track either to the track hopper feeding the conveyor system to the boiler room, or to some point along the storage pile where it can be dumped underneath.

As the coal piles up under the trestle it also flows out on each side to a certain distance, so that the bucket can dig into this part of the pile outside the trestle, or, on account of the wide gage of the track, it can go down between the rails and pick up coal in the center and spread it out in a wide pile along the trestle. In this way the crane distributes the coal over a large area on each side of the trestle, the pile in this case being about 60 ft. wide at the top and about 90 ft. at the bottom, that is, at the foot of the slope. The average depth of this pile is about 15 ft., and the amount of coal per foot of length figures about 30 tons. The length of the pile which is used for bituminous coal for the new power house is 130 ft., which means a storage of about 4000 tons. The small anthracite coal is handled in the same way, and about 3000 tons are stored at the other end, and this coal is transferred to the vaults alongside the old boiler room in the same manner as before, that is, with an automobile truck which is loaded by means of a portable wagon loader.

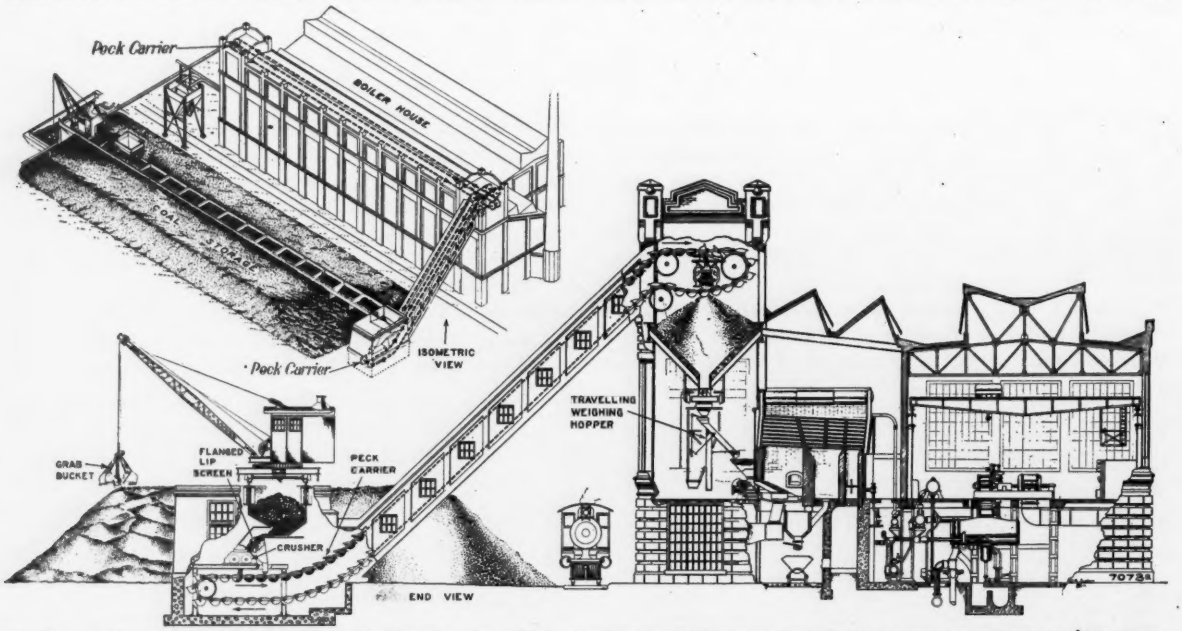


FIG. 2. DRAWINGS SHOWING GENERAL SCHEME OF COAL HANDLING SYSTEM AT VICTOR TALKING MACHINE CO.'S PLANT

Conveying to Overhead Storage Bin

The foregoing describes the method of unloading and storing the coal in the outside storage. The second step in the handling is to get it into an overhead storage bin in the power house. This bin is designed to hold 800 tons and there are eventually to be 12 500-hp. boilers, so that the daily coal consumption may run up to 200 tons, which would mean that the overhead supply in the bin would last about 4 days.

A general view of the power house is shown in Fig. 2. The generator room is on the north side, and the boiler room on the south side. The boiler room is 220 ft. long by 50 ft. wide, the walls being of brick with steel columns

spaced at intervals of 16½ ft. The 500-hp. Edge Moor boilers are placed in batteries of two, with the fronts facing south. The operating floor is 16 ft. above the wharf level, and there is a first floor or basement at the wharf level. The boiler room is built with the coal bin on the south side, directly over the space in front of the boilers, which is about 20 ft. wide, and this part of the building is carried up considerably higher than the part directly over the boilers. This high part provides for the bin and the distributing coal conveyor over the bin, and the space underneath is used for the movable weighing hopper and allows plenty of room for the removal of tubes. The bin is made up with steel girders running longitudinally between the steel building columns and a

After the coal is dumped into the track hopper it is fed by means of a reciprocating feeder to a crusher. This feeder consists essentially of a plate forming the bottom of the hopper, so that the coal rests upon it, and to which a forward and back movement is given by means of an eccentric on a shaft which is driven by a chain drive from the crusher countershaft. The plate is supported by rollers, and as it moves forward the coal resting on it moves with it and other coal slides down at the back to fill up the space formed. The plate then moves back and the coal at the forward end falls off into the crusher. This movement is repeated 25 times a minute, so that the feed to the crusher is practically regular and choking is avoided.

FIG. 3. CRUSHER HOUSE AND INCLINED CARRIER TO BOILER ROOM

V-shaped bottom formed by means of steel beams which are framed into the girders at the top and fastened together at the bottom. The body of the bin is built of reinforced concrete resting on the inclined steel beams. The conveyor is supported on steel trusses over the bin, and these steel trusses also support the roof. The front of the building is amply provided with windows for light and air. Over the boilers, I-beams span from the steel girders at the front of the boilers to the rear wall of the boiler room, and these beams support a saw tooth roof, which allows additional light and ventilation.

The track hopper above the feeder is built of ¼-in. ingot iron plate properly braced and stiffened with steel angles, and it is hung from the steel trestle girders. The top of the hopper is 10 ft. wide at right angles to the track and 15 ft. long parallel to the track. The plates of the hopper are sloped at an angle of 45 deg., so as to direct the flow of coal down to the feeder plate, which is 3 ft. wide and 5 ft. 10 in. long and constructed of ⅜-in. ingot iron.

The crusher is of the 2-roll type with rolls 28 in. diameter by 24 in. long, these rolls being of cast iron

and cast in chills to make the exterior surface very hard. The roll shafts revolve at a speed of 56 r.p.m. in babbited cast-iron bearings, which are carried by a cast-iron frame and one pair of which has relief springs which allow one roll to move back and avoid a breakdown in case a foreign substance gets between the rolls. The space between the rolls is such that the coal is crushed to a size of 2 in. and under. The crusher frame is set directly on heavy steel framework a few feet above the concrete foundations and directly over the carrier which takes the coal up to the top of the boiler room. It is driven by a 15-hp. motor, which also drives the reciprocating feeder. The drive from the motor to the countershaft of the crusher is by means of a belt, which provides an additional safeguard in case some foreign substance gets into the crusher, and the countershaft and roll shafts are connected together by means of spur gears, those connecting the roll shafts together having especially long teeth, so that they will not get out of mesh when the rolls move apart a moderate distance.

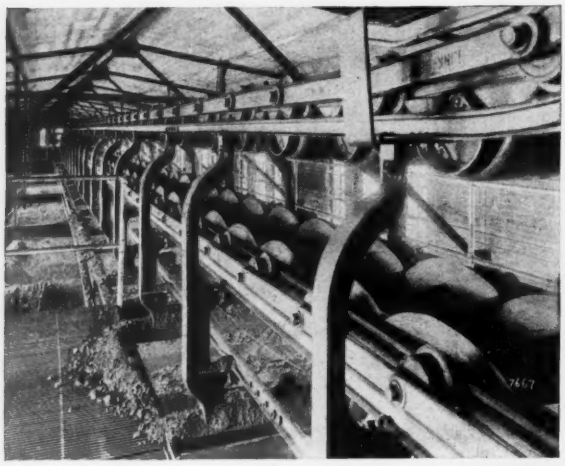


FIG. 4. DISTRIBUTING CARRIER OVER COAL BIN IN BOILER ROOM

For elevating the coal and distributing it in the overhead bin there were several types of conveyors which could have been used, but the Victor Co. selected the Peck Pivoted Bucket Carrier for both operations. These machines have 2 strands of heavy malleable iron chain of 24 in. pitch, and between the chains are suspended 24 by 24 in. malleable iron buckets cast in one piece and with a thickness of metal of about 3/16 in. and with overlapping lips to prevent the coal from spilling between them when it is fed into them.

The buckets are pivoted on cross rods carried by extensions of the inside links and, on account of the pivot points sweeping around the turns in a larger circle than the path of the chain joints, the buckets lap and unlap properly at the turns without the aid of any auxiliary device. At each chain joint there is a high carbon steel pin fitted into one pair of links and a case-hardened steel bushing fitted into the other pair of links and both pin and bushing keyed to the links, so that the only movement, when the chain bends around the wheels, is between the hard steel surfaces of the pins and bushings. This gives a large bearing surface in the joints and a surface of the most excellent materials for resisting wear. The links are thus relieved of all wear and the pins and bushings are easily renewable at small expense when they finally do become worn.

On the outside of each bushing there is a 6-in. flanged roller with a hard chilled tread and cast with an oil chamber holding, under ordinary operating conditions, about 3 weeks supply of oil. The oil is injected into the roller through a Bennett oiler and filters slowly through a felt washer to the bushing and on through a slot in the bushing to the pin. This arrangement insures a well oiled joint and reduces the friction and the wear to a minimum. Also, the oil coming from the inside and working out tends to force the dirt out of the joint rather than into it. The chains are driven by means of sprocket wheels at the driving turn, the driving shaft being geared direct to a motor with an intermediate countershaft and the gears next to the driving shaft are of the equalizing type to eliminate the irregular motion always accompanying long pitch chains. On the horizontal and inclined runs the chain rollers travel on regular T-rails supported by cast-iron rail chairs attached to the steel supporting framework and to the concrete work underneath the crusher.

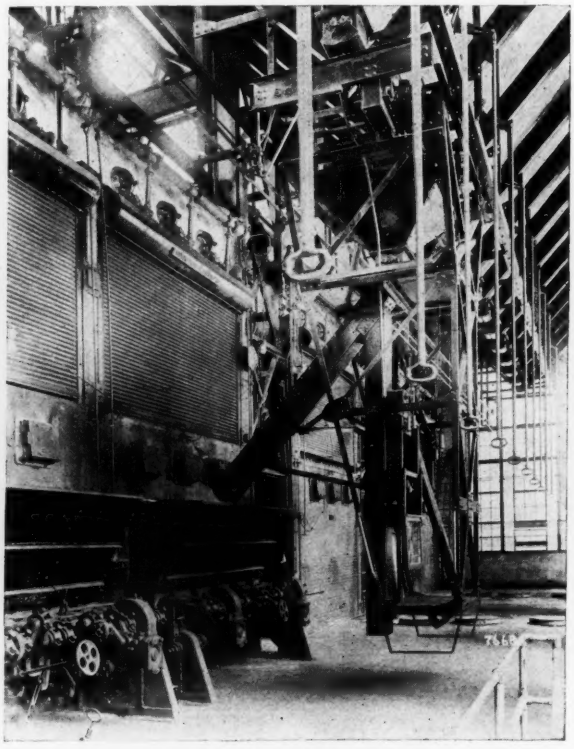


FIG. 5. TRAVELING WEIGHING HOPPER ARRANGED TO SPOUT TO STOKERS OR TO HOPPERS UNDER FLOORS IN FRONT OF REFUSE BURNING BOILERS

The carrier which takes the coal up to the top of the bin is set at an incline, the coal being delivered from the crusher to the carrier buckets at the lower end and discharged at the upper end by means of a fixed tripper which tilts the buckets sufficiently to dump the coal out into a chute leading to the buckets of the distributing

carrier over the coal bin. This second carrier takes the coal out along the bin and it can be discharged at any desired point by means of a tripper which is moved along on another pair of T-rails. In this way the bin can be completely filled with coal. The speed of both carriers is 40 ft. per minute, and the capacity is 40 tons per hour. The inclined machine is driven by a 7½-hp. motor and the horizontal machine is driven by means of a 5-hp. motor. These motors are geared to the driving shafts of the machines through an intermediate countershaft and spur gears, and the drive from the motor to the first countershaft is accomplished with a silent chain drive.

Delivering to Boilers

Underneath the coal bin there are castings attached to the bottom of the bin and duplex cutoff gates operated by means of levers hanging down alongside the traveling weighing hopper. This weighing hopper has a capacity of 1 ton of coal and is electrically propelled along steel

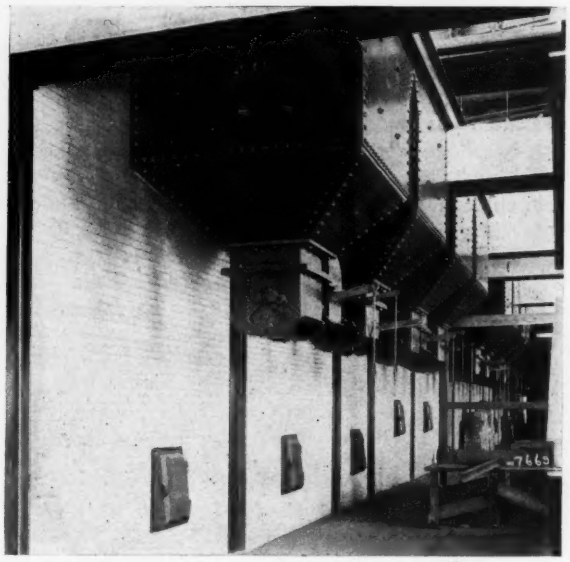


FIG. 6. ASHES HOPPERS AND FLUE DUST CHUTES IN BASEMENT WITH GATES FOR DELIVERING TO CARS

angle iron tracks supported from the coal bin. The hopper is filled by means of the gates in the bottom of the coal bin and the load of coal is then weighed on the scale beam and a ticket punched by a ticket punching device, which records the weight of the coal. The hopper is then placed in front of one of the Taylor stokers and the coal delivered by means of a chute with a cutoff gate to the magazine of the stoker, from which it feeds automatically into the stoker furnace.

Two of the boilers at the east end of the boiler room are fitted with furnaces for burning wood refuse as well as coal, and the coal supply for these boilers is fed from the weighing hopper, by means of another chute, to hoppers under the boiler room operating floor, this coal being fired by hand to the furnaces. The weighing hopper has a platform about 3 ft. above the floor for the operator to ride along on and the levers for operating the bin gates, the discharge gates to the stokers, and the operating cords for traveling the machine along, are within easy reach.

The ashes handling system has not yet been completed, but is to consist of an industrial railway with cars pushed by hand, and a skip hoist delivering to an overhead bin from which the ashes can be discharged to carts, automobile trucks or railroad cars. Underneath the ash dumps of the stokers there are brick lined hoppers holding about 2½ tons of ashes per boiler, and at the bottom of these hoppers there are duplex cutoff gates with levers extending out sideways, so that the operator can easily get hold of the lever rods to open the gates.

There are also pipes leading down from underneath the boiler tubes to take care of the flue dust from the tubes. The cars of the industrial railway system run on a track directly underneath the hoppers and flue dust chutes, so that these materials can be delivered directly to them. The overhead bin is to be erected over the railroad siding at the west end of the boiler room. The skip which takes the ashes up to the top of the bin is to have a capacity of 1¼ tons of ashes, and is to be hoisted by an electrically geared drum arrangement with an automatic control system so that all that the operator has to do is to fill the skip and push a button which starts the machine, after which the skip travels to the top, dumps its load and returns automatically to the foot of the incline. The industrial cars, which are of the side dump type, holding about ¾ of a ton, will dump directly into the skip. The framework of the overhead bin is to be of steel and the body of the bin is to be of steel lined with concrete. The house over the top of the bin enclosing the machinery is to be of steel framework covered with corrugated iron. The skip will be driven by a 20-hp. electric motor.

The general design of this power house and the equipment for it were under the direction of Albert C. Wood, consulting engineer, and the building itself was designed by Ballinger & Perrot, architects and engineers. The locomotive crane was built by the Browning Co., the weighing car by the Atlas Car & Mfg. Co., and the coal handling equipment by the Link-Belt Co.

During the fiscal year of the National Gas Engine Association, now nearly 8 yr. old, the number of engine manufacturers who have joined has been larger in proportion than in any previous year. This has been due, no doubt, to a number of things undertaken by the present administration, such as the data sheets—170 of which have been issued during the year—private information on engine prospects, etc., and with the increase in the work along tractor lines that the association proposes to do, there are still further opportunities for membership. A recent examination of the list of members shows that over 60 per cent are gas engine manufacturers. Not only have many more engine manufacturers become actively identified with the association, but increasingly important ones have joined, so that today the aggregate number of engines put out by the members of the body is an exceedingly large percentage of the total number of engines built. It is hoped that within a short time this record may be increased even further, so that every engine manufacturer of any consequence may be affiliated with this association.

Illustrated Action of Valve Gear

Various Positions of Mechanism Photographed to Show Actual Performance

IN THE 3 accompanying figures, reproductions from photographs, are shown the linkage and the valve motion of Ideal Corliss steam engines during the various parts of their working cycle. The cover has been removed from the gear box, disclosing the linkage within, and the pointers and dials have been attached to show the movements of the mechanism.

Figure 1 shows the gear in one of its extreme positions for latest cutoff, the steam rocker arm having traveled as far as it can go toward the left.

rocker arm to its extreme right-hand travel. During this period it will be seen that the lower pointer, indicating the movement of the valve-driving shaft, has picked up the movement and has taken 6 successive corresponding positions. It also will be observed that this motion is of a character which picks up without shock and rapidly accelerates.

In Figs. 2 and 3 the several steps can be retraced for the return stroke of the steam rocker arm, which is driven by the governor eccentric.

In order not to obscure the pictures, a pointer has been attached to the left-hand shaft only. The movement of the right-hand valve-driving shaft is identical except that it functions just 180 deg. from the other

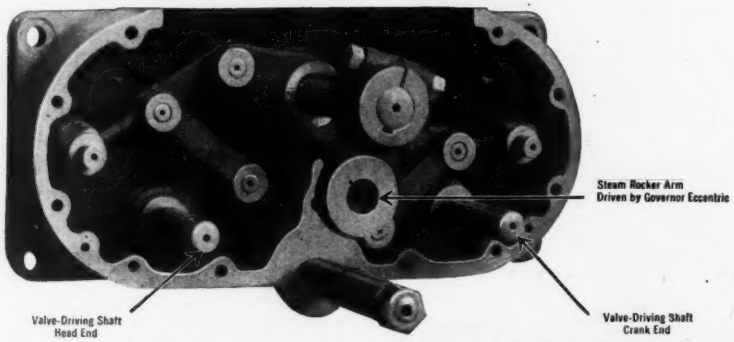


FIG. 1. STEAM ROCKER ARM HAVING REACHED ITS EXTREME POINT OF TRAVEL TOWARD LEFT

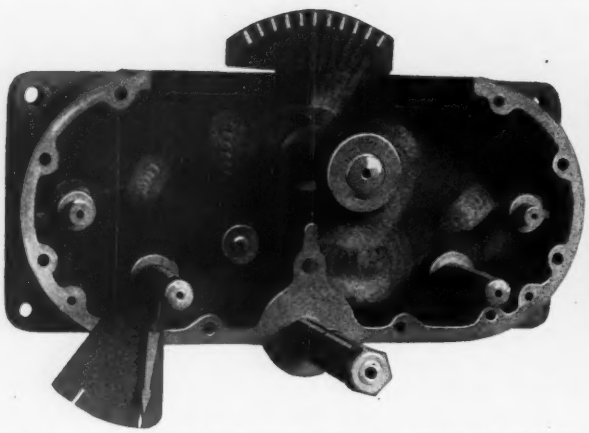


FIG. 2. SUCCESSIVE POSITIONS TAKEN BY GEAR AS ROCKER ARM TRAVELS FROM EXTREME LEFT-HAND POSITION TO CENTER POSITION

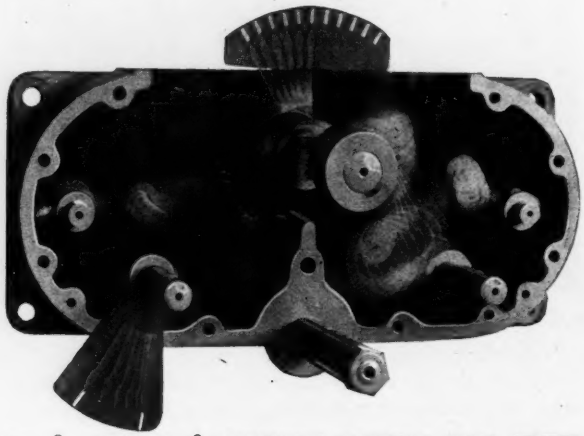


FIG. 3. GEAR IN 6 SUCCESSIVE POSITIONS FROM CENTER POSITION OF STEAM ROCKER ARM TO ITS EXTREME RIGHT-HAND POSITION

Figure 2 shows the successive positions taken by the gear as the steam rocker arm travels from its extreme left-hand position to center position. This figure is made by setting the gear into each of 6 successive and equally spaced positions, and then re-exposing the plate to photograph the linkage in each position. It will be observed that while the rocker arm is traveling from the extreme left-hand position to center position, the head-end valve-driving shaft, to which the lower pointer is attached, has remained absolutely stationary, thereby holding at rest the valve to which it is connected.

Figure 3 completes the stroke by showing the gear in 6 successive positions from center position of the steam

one; the right-hand valve driving shaft is at rest during the half revolution that the left-hand valve-driving shaft moves; and the right-hand valve-driving shaft moves during the half revolution that the left-hand valve-driving shaft is at rest.

A FOREIGN TRADE investigator states that Russia is anxious to purchase in large quantities motor-driven exhaust fans, valves of various types, radiators and heating equipment, centrifugal pumps with motors attached, insulators, direct and alternating current motors of low voltage and small capacity, air compressors, and water piping.

Interpretation of Coal Analysis*

SPECIAL REFERENCE TO NON-COMBUSTIBLES. BY E. G. BAILEY

THE purpose of a test on coal or any other material is to arrive at definite conclusions by a short cut, and yet with sufficient accuracy that the results of the test may form the basis of comparison for the purchase or use of the material tested. There is no test, nor can there be any test, that will replace results obtained from actual practice. But it is impossible to burn 2 coals under the same conditions at the same time, and it is unnecessary to state that in actual practice conditions do vary, so that comparisons based upon actual service results alone are often unfair to one coal or the other, or at least they lead to indefinite conclusions.

As a rule, the chemist passed his figures on to the purchasing agent or superintendent of motive power with little or no comment or interpretation. The man who is responsible for the buying or burning of the coal is most interested in making a comparison of it with other coals which he has used or which are available. He accepts the figures from the chemist for the purpose of such comparison, and proceeds to draw certain conclusions as to the relative value of the two coals, based upon one or two constituents, such as the percentage of ash, sulphur or B.t.u., according to his own ideas of what the chemist's figures really mean. Often these conclusions are not borne out by the practical tests or the actual use of the coal in regular service. Theory and practice do not always agree, has often been repeated when the results obtained in the actual burning of the coal did not bear out the figures of the chemical analysis as interpreted by the person making the comparison. But theory and practice should and do agree when they are both right. Too often one is based upon erroneous data, incomplete results, or else failure to duplicate conditions.

A careful insight into this problem shows that the real cause of the difficulty was that the comparison was limited to the one factor of heating value. While this may be the item of primary importance, yet the effect of the non-combustibles upon the action of the coal in the firebox had such a modifying influence that frequently the coal with the higher heating value gave the poorer results. Anyone who has depended upon coal analyses without the proper interpretation, and has not given full weight to the effect of the impurities which accompany the heat producing elements, has not been able to secure very much benefit from coal analysis.

The usual analysis of coal gives the percentage of moisture, volatile, fixed carbon, ash and sulphur, in addition to the heating value. The ultimate analysis, dividing the constituents up into their elements, gives carbon, hydrogen, oxygen, nitrogen, sulphur and ash. This is very seldom used, first because the analysis is more expensive, and second because the analysis really gives less information than the usual proximate analysis. Let us therefore confine our attention to a study of the promixate analysis.

*Abstract of paper read at the annual meeting of the International Railway Fuel Association.

Moisture is of course non-combustible. It produces no heat, but is on the other hand an absorber of heat, as it must be vaporized and sent from the boiler as superheated steam at the stack temperature. Assuming a stack temperature of 700 deg. F. (365 deg. C.), the total heat required to vaporize and superheat 1 per cent of moisture amounts to only 1/10 per cent of a 13,000 B.t.u. coal. This of itself is not a serious matter, so that the principal importance of moisture is that it acts as so much inert matter, which is paid for at the same price as coal. This applies only to the moisture which is in the coal at the time of its being weighed. It must be remembered that the percentage of moisture as shown by the usual analysis does not include all of the water or H_2O compound present in the fuel, for there is a considerable amount of water that cannot be dried from the coal even at 220 deg. F. (105 deg. C.), but remains in chemical

ANALYSIS OF A TYPICAL WEST VIRGINIA COAL.

				Heating Value Per Pound	Calculated B. T. U.	B. T. U. by Calorimeter
Moisture	2.01	H 0.22	2.01 water	None		
		O 1.79				
Volatile	37.31	H 4.86	5.38 water	None		
		O 4.78	4.26 available H.	62,000	2,641	
		C 26.65		14,500	3,464	
		N .23		None		
		S .79		4,050	32	
Fixed Carbon	52.13	C 49.18		14,500	7,131	
		N 1.20		None		
		S 1.75		4,050	71	
Ash	8.55			None		
					13,339	13,811

ANALYSIS OF A TYPICAL ILLINOIS COAL.

				Heating Value Per Pound	Calculated B. T. U.	B. T. U. by Calorimeter
Moisture	12.39	H 1.38	12.39 water	None		
		O 11.01				
Volatile	36.89	H 4.47	9.01 water	None		
		O 8.01	3.47 available H.	62,000	2,150	
		C 23.10		14,500	3,363	
		N .10		None		
		S 1.12		4,050	46	
Fixed Carbon	41.80	C 38.10		14,500	5,525	
		N .90		None		
		S 2.80		4,050	113	
Ash	8.92			None		
					11,197	11,399

combination probably as a carbohydrate, and can only be driven off with the volatile. Therefore a considerable percentage of impurities is included in the volatile, although it is usually considered that the moisture, ash and sulphur are the only impurities present.

The real basic impurities in coal are oxygen, nitrogen and ash, so far as generating heat is concerned. Sulphur is generally classed as an impurity because its heating value is so low that the heat produced does not compensate for its detrimental qualities. According to the best authorities all of the oxygen which occurs in coal is combined with hydrogen, either as moisture, combined water or in the form of a carbohydrate, and that which is not shown in the analysis as moisture is included in the volatile.

The above tabulated data of a typical West Virginia gas coal give the division of the volatile matter into its different elements, hydrogen, oxygen, carbon, nitrogen and sulphur. It is noted that in the volatile

there is a total of 5.38 per cent of the total coal, or about 13 per cent of the volatile, that is water, besides some nitrogen and sulphur as noncombustibles.

Making a similar division of the proximate analysis of a typical Illinois coal, we find that 9 per cent of the total coal occurs in the volatile in the form of water, or 25 per cent of the volatile itself is non-combustible. In the case of lignite and peat, the percentage of volatile which is non-combustible proportionately increases. So that in this we see that volatile itself is not an indication of rich fuel, for much depends upon the nature of the volatile, and how much of it is impurities and how much combustible. Then in the combustible itself there is considerable variation, depending upon the relative percentages of available hydrogen and carbon.

Percentage of moisture retained in coals varies widely with the characteristics of the coal. Lignite and subbituminous coals carry a much higher percentage of moisture than do the bituminous and semi-bituminous.

Anthracite coal, on the other hand, carries a slightly higher percentage of moisture than does semi-bituminous.

This point should be taken into consideration in comparing coals from different fields. Many people have considered that the percentage of moisture was such a variable quantity, depending upon weather conditions, etc., that the only true comparison was on a dry basis, and they therefore reduce all analyses to this basis, and make their comparisons on it. This is likely to lead to very erroneous conclusions. For instance, take Illinois coal, which may run normally with say 12 per cent moisture, and a bituminous coal from the Pittsburgh or West Virginia district, which would run normally 3 per cent of moisture. If these are both reduced to a dry basis, the Illinois coal will show an apparent advantage of about 9 per cent better than it should.

In order to get a more uniform basis of comparison it is all right to compare different shipments of coal from the same region on a dry basis, but it is not right to compare coal of one character with another coal from another region of different character on any other basis except with their normal moisture content that is fairly representative of the different districts.

A coal which normally has a high moisture content usually has a relatively large percentage of its volatile matter in the form of combined water, and is therefore just as inert and non-productive of heat as if it showed up as moisture in the regular analysis. The only practical way that this can be taken care of is through the B.t.u., for such coals show lower heating value per pound of combustible, or on a basis free from moisture and ash.

The impurity which is always present in coal, and the one which is of the greatest importance, is the ash. The ash is a very different proposition from the moisture, for it is not only inert and non-productive of heat, but it may have very marked effect upon both the rate and efficiency of combustion.

Composition of ash varies widely. In all cases it is a complex compound, consisting of alumina, silica, iron, lime, magnesia, titanium, alkalies, etc. Practically all of these compounds are always present. The relative percentage of each varies widely, and the effect of them upon the action of the coal in the firebox varies according to such a complicated law that it is practically impossible for this analysis to be used as a reliable means of determining the character of the ash for comparative purposes.

An ash which does not clinker gives little trouble, and is not much if any more detrimental than so much moisture. It is merely an inert substance that does not produce heat. It does not seriously obstruct air passages, and can easily be shaken through the grates. But an ash which melts into a clinker is more difficult to get rid of, and while remaining on the grates it obstructs the flow of air to a serious extent, and oftentimes it adheres tightly to the grates and obstructs the air so completely that the heat of the fuel bed is conducted to the grate bars and causes them to burn.

Heretofore practically the only means of getting any line upon this important characteristic of fuel was the actual trial. At the same time, it has always been realized that some firemen would make more clinkers than others using the same coal, so that such results obtained from actual practice were not always a safe comparison so long as the fireman was a factor in the problem.

A thorough study into this phase of the fuel problem some years ago led the writer to conclude that the whole question of clinkers could be summed up in the fusing temperature of the ash and the temperature to which this ash is subjected. Some coal ash has such a high fusing temperature that there are practically no fuel bed conditions that will produce troublesome clinker from it. Another ash with a little lower fusing temperature will clinker together and form a porous, spongy clinker which does not form a serious obstruction to the flow of air, nor is it difficult to remove. The ash with a still lower fusing temperature, say 2100 deg. F. (1149 deg. C.), will not only become melted in the average firebox, but it will be heated several hundred degrees above its melting temperature, in which case it runs down like overheated iron until it spreads out in a thin sheet over the grate bars.

To a certain extent the action of a clinker depends upon its fusing temperature, but equally important is the temperature to which the ash is subjected. When a coal is burned, the ash is not entirely liberated until it reaches the lower part of the fuel bed, where the incoming air keeps a lower temperature than in the zone 4 to 6 in. above the grates. So it is often possible to get satisfactory results from a coal having a fusing temperature of 2300, and yet carrying a fuel bed temperature of 2500. Some clinker, of course, will be formed, but it is not of the extremely objectionable character if the firing is properly done. Clinker accumulates gradually, and is more or less open and does not obstruct the air beyond the critical limit. But if another fireman should handle the same coal differently, slicing or working the fire, and causing the ash, which has already been liberated from the coal in the lower and cooler part of the fuel bed, to be again thrown up into the hotter zone, it will melt into a very fluid mass and spread out over the grates in a thin sheet, and obstruct the air flow to a serious extent.

Many people have considered that the percentage of sulphur was a true indication of the clinkering property of a coal. The sulphur determination, however, is one of the ideas that have been passed on from the steel chem-

ist. In his case sulphur was extremely detrimental, but in the case of steam coal it is of minor importance. It is true that in some coal fields the variation in the clinkering property of coal received from different mines does follow the percentage of sulphur to a certain extent. Sulphur is an indirect cause, however, for it is really the iron which has the effect upon the fusing temperature, and the percentage of iron usually increases or decreases with the sulphur. There are so many exceptions to the relation between sulphur, or even iron, and the clinkering property of coal, however, that a dependence upon either is apt to lead to erroneous conclusions.

One of the very lowest sulphur coals in the United States is found in Rhode Island, where the percentage of sulphur will run less than one-quarter of 1 per cent, yet the fusing temperature and the clinkering property of this coal class it among the very worst in this respect.

Several of the largest stationary power plants in the country are making fusing temperature determinations in addition to the regular analysis on each shipment of coal. In many respects the clinker problem is of more serious consequence in railroad practice than it is in stationary boilers. The matter of fusing temperature determination has not as yet been standardized from a laboratory standpoint to the extent that the regular analysis and B.t.u. determination have been. The value of this determination has been demonstrated so conclusively that there is now under way a definite movement to work out the fundamentals of this problem and decide upon a method which can be adopted as standard for comparison. It is the writer's opinion that the method which will ultimately prove most valuable for this determination is the one which stays closest to practice, so far as duplicating the actual fuel bed conditions is concerned.

Measuring Blowoff Water

Advantages to be Gained and a Simple Method Proposed

THE desirability of measuring and recording the amount of water blown down from the boilers is one feature that is overlooked in the vast majority of plants, even though they are operated in accordance with the most modern and progressive ideas.

Blowing-off represents a source of loss of water, and also a loss of fuel in the form of heat units, hence some indication and record should be secured to show just what this blowoff amounts to, so that a close approximation of the loss can be obtained and charged off as such, and also that it may be checked and compared with the loss in previous periods, and at various loads, from which data a standard practice for blowing down which should result in the minimum loss with the maximum efficiency can be evolved.

It is of course desirable to keep the amount of water blown off down to the lowest possible quantity, while preventing foaming and scale troubles. A careful study of the blowoff records covering a number of periods of operation should enable the operators to accomplish this desideratum.

The record of the quantity of water which is blown down is also essential to the securing of the most accurate statement of the boiler efficiency and the cost of steam, because this blowoff water should be accounted for as such, and should not be accounted for in the amount of steam actually produced, although of course it should figure in the cost of steam.

Still another advantage of having a meter located in the blowoff line is that it readily shows up leaky blowoff valves, and acts as a safeguard against otherwise unnoticed losses from this source. If, after the boilers are blown down, the meter still continues to register the flow of water, it is a sure sign that some of the blowoff valves have not been closed tightly, or are leaky and defective, and hence require attention.

As stated above, there is also a loss of heat units in this blowoff water, the quantity of which can be definitely determined if the amount and temperature of the blowoff water is determined. These heat units also should be charged against "blowing off," and should not be included in the records as steam actually produced.

A very simple and inexpensive arrangement for securing a measurement of the boiler blowoff is shown in the accompanying sketch Fig. 1, from which it will be noted that the blowoff water is measured as it flows out of the blowoff tank to the sewer. With the meter located at this point the blowoff tank acts as a reservoir or cushion for smoothing out the flow of the water, which as it comes through the blowoff pipe from the boiler would be practically impossible to measure with any degree of accuracy and reliability.

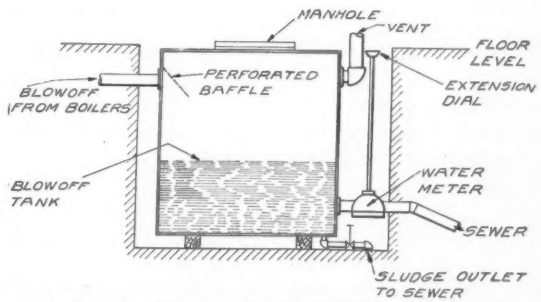


FIG. 1. BLOWOFF TANK WITH METER IN OUTLET

Water blown down from the boilers is admitted to the blowoff tank near the top, strikes a perforated baffle, and settles down to the bottom of the tank in a more quiescent state. It then flows out to the sewer through a low head meter of the disk or turbine type, which while not accurate to the extreme degree, will give satisfactory results for the service. This meter can be arranged with an extension dial by means of which the flow can be observed from the boiler room floor. In making the installation, access should be afforded to the meter proper so that it can be readily cleaned and kept in good operating condition.

The outlet from the blowoff tank to the meter is raised about 8 or 10 in. above the bottom of the blowoff tank, to allow most of the heavier sediment, which might clog the meter or vitiate the readings considerably, to settle to the bottom of the tank, whence it can be blown away through the sludge valve.

The arrangement shown in Fig. 1 is in a way a crude make-shift to provide some sort of measurement for the blowoff, though it has the advantage of being simple and easy to install. More accurate meters of various types could be installed for the same purpose, and would undoubtedly prove to be good investments.

If, however, any measuring equipment is provided for taking care of the blowoff, the full benefits can only be derived from the information secured by keeping a running record of the time of blowing down, the duration, the amount of water blown down each time, and other data as to boiler pressure, feed temperature, etc., which will enable the operator to determine the amount of heat which is lost in the water blown off.

FIG. 2. FORM FOR RECORDING WATER LOST BY BLOWING DOWN

No.____ Report on Blowing Down of Boilers. Week Ending._____19_

	Time of blowing down	Approximate duration	Meter dial before blow down	Meter dial after blow down	Difference - pounds water blown down	Approx. load carried on boilers	Boiler press. & total heat per lb. steam	Feed water temperature	Heat lost per lb. blown off	Heat lost in total blowoff	Remarks
Monday											
Tuesday											
Wednesday											
Thursday											
Friday											
Saturday											
Sunday											
Total & Average duration			Total & Average Amount								Averages should be supplied for last 5 columns.

All this data and information can be very nicely collated on a Blowoff Report Sheet, as shown in Fig. 2. Provision is made to record the necessary data for each week's run, and also at the end of the week to ascertain the average duration of the blowing down, the total and average amount of water blown down, as well as averages of the boiler pressure, temperatures, etc. This summarization of the week's run is extremely useful for use in making comparisons with previous runs to ascertain just when the most desirable condition is reached. A "Remarks" column is also provided for noting any special conditions which arise in this particular branch of the boiler operation, and in which may also be kept a record of when the blowoff valves are repacked, replaced, etc.

A COMMERCIAL agent of the Bureau of Foreign and Domestic Commerce writes that a business man from Spain is now in the United States for the purpose of establishing commercial relations with American manufacturers of electrical supplies, textile machinery, builders' hardware, rubber goods, etc. Catalogs should be sent immediately. Correspondence may be in English, but is preferred in Spanish.

Gasoline from Shale

IN view of the ever-increasing demand for gasoline and the increase in price of crude oil, from which it is obtained, it is important to know that an almost inexhaustible supply of oil may be obtained from the shale of northwestern Colorado, northeastern Utah, and southwestern Wyoming. This shale contains materials which, when heated, may be converted into crude oil, gas, and ammonia. The high cost of distilling oil from shale as compared to the cost of producing oil from wells has thus far prevented the development in this country of such an industry and may continue to prevent it for some time, but sooner or later this great source of supply will be utilized to supplement the decreasing production from the regular oil fields.

Oil derived from the shale is similar to that being produced from wells in the United States at the rate of more than 250,000,000 bbl. a year. When refined by ordinary methods the shale oil yields an average of about 10 per cent gasoline, 35 per cent kerosene, and a large amount of paraffin, and the yield of gasoline from the shale may probably be largely increased by the use of refining methods especially designed for that purpose. The gas, which is a very good illuminating gas, will perhaps be sufficient to furnish all the heat required to distill the crude oil from the shale.

The ammonia is a most valuable by-product of the distillation and may be utilized in the manufacture of commercial fertilizer or other nitrogen compounds, as the market demands. The United States Geological Survey has examined large areas of the shale in Colorado, Utah, and Wyoming and has made many distillation tests. Some beds of shale that are several feet thick will yield more than a barrel of oil to the ton of shale, and one bed 6 in. thick will yield more than 2 bbl. of crude oil to the ton of shale. One ton of this shale should therefore yield nearly 10 gal. of gasoline by the present commercial methods of gasoline extraction, and larger yields may be made possible by new methods.

Little attention has been paid to this shale because the quantity of petroleum produced from wells in the United States has been sufficient to satisfy all demands, but for more than 50 yr. the oil shale industry of Scotland has been important. In a recent year more than 8000 men were employed in the industry in that country, yet the average yield of oil per ton of shale was much less than that which appears possible from the shale of Colorado and Utah. It is estimated that in Colorado alone there is sufficient shale, in beds 3 ft. or more thick and richer than the shale being mined in Scotland, to yield 20 billion barrels of crude oil, from which at least 2 billion barrels of gasoline may be extracted by ordinary refining processes.

As was stated in the recent reply of Secretary Lane to a Senate resolution on the subject of gasoline: "The development of this enormous reserve simply awaits the time when the price of gasoline or the demand for other distillation products warrants the utilization of this substitute source. This may happen in the future. At all events these shales are likely to be drawn upon long before the exhaustion of the petroleum fields."

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Rigid Conduit Wiring Hints—I

DUE TO THE MORE GENERAL EMPLOYMENT OF THIS FORM OF WIRING DETAILED INFORMATION RELATIVE THERETO IS DESIRABLE. BY TERRELL CROFT

THE function of a conduit system is to provide a permanent raceway for the protection of electrical conductors and which will at the same time permit the withdrawal and replacement of the conductors if such is desirable or necessary. The conduit, which is specially treated steel pipe, and the pressed steel outlet and terminal boxes are obviously well qualified to protect the conductors encased in them from mechanical injury and also to prevent the spread of fire outside of the conduit system in case the insulation on the conductors within the system becomes ignited because of an accidental ground or short circuit. A conduit system should of itself have relatively high electrical conductivity because under certain abnormal conditions, discussed later, the pipes and other metal of the installation may carry current. Hence they must have sufficient conductivity so that they can carry such currents for the short periods that will ensue before the cut-out (fuse or circuit breaker) protecting the circuit operates and discontinues the circuit. Normally, the conduit does not and should not carry current, but under abnormal conditions it may carry current and must be proportioned and assembled accordingly.

Rigid conduit provides the safest and best method of wiring, and should, in general, except under certain special conditions, be used in preference to other methods. Its disadvantage is that it is the most expensive.

CONDUCTOR INSULATION AND SPLICES

RUBBER-INSULATED WIRE must be used in conduit. Obviously the conductors of opposite polarity within a conduit are in close proximity and the insulation between them is determined solely by the quantity and quality of material (insulation) in which the copper conductors are encased. It is evident then that only the best and most effective materials should be used for insulating these conductors. Prior to the 1915 Code rules, double-braided, rubber-insulated conductors were required for conduit work. Experience has shown, however, that single braid insulation is ample for this service for conductors smaller than No. 6, B. & S. or American Wire-Gage. Now single-braid rubber insulation is approved for conductors smaller than No. 6, for knob-and-tube, molding, conduit and open work, rendering it unnecessary for the dealer to stock these wires with 2 kinds of insulation as was formerly required.

Splices or taps should never be made within the conduit tubing because a splice or a joint is of necessity weaker electrically than the unimpaired conductor. If splices were permitted within the conduit tube, the insulation strength of the system would be materially weakened. Splices and taps should, as hereinafter shown, be made only in accessible outlet or junction

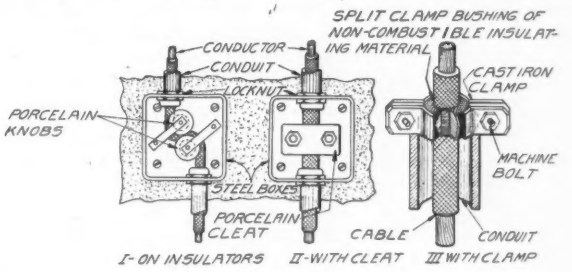


FIG. 1.

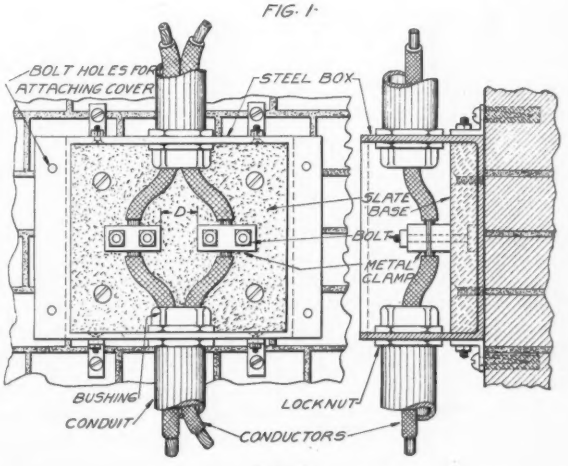


FIG. 2

FIG. 1. METHOD OF SUPPORTING CONDUCTORS IN VERTICAL CONDUIT RISERS

FIG. 2. ANOTHER METHOD OF SUPPORTING RISER CONDUCTORS IN CONDUIT

boxes. Furthermore, a splice is of necessity, if it is made in accordance with the Code rule, of greater overall diameter than the conductor in which it is made. Therefore, if a splice is drawn into a conduit tube, there is danger of the insulation round the splice being disturbed and of the joint being injured mechanically.

Method of Installing Conductors

The conductors of a conduit system should not be drawn in until the mechanical work in the structure has been completed. This is necessary in order to prevent unauthorized workmen from damaging the insulation on the conductors or the conductors themselves, where they extend from the outlet boxes, and furthermore, to insure that the conductors can actually be removed and replaced after the building is finished. Frequently conduit in a building under construction is battered and crushed after its installation, even when the building is nearly completed. If the conductors were already in such tubes they might be wedged, preventing withdrawal. Furthermore, if the wire is pulled into a conduit system before the runs are fully encased in floors and partitions the wireman may, if he experiences difficulty, open a conduit run at a running-thread joint or at a coupling, to facilitate his work, and pull in wires both ways from a break thus made. Obviously, conductors installed by such methods may be impossible of removal.

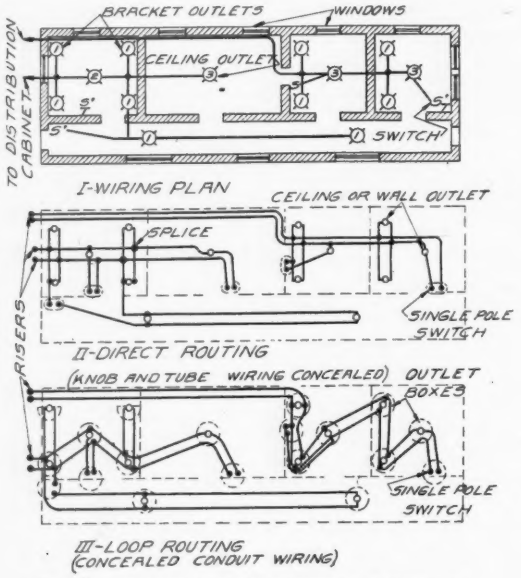


FIG. 3. DIRECT AND LOOP WIRING ROUTINGS

Conductors in vertical conduit risers should be supported to prevent excessive strains due to the weight of the conductors being imposed on the lugs and binding posts of the switches or cut-outs to which the conductors connect.

There are 3 approved methods of supporting vertical conductors. The first of these is illustrated in Fig. 1, III, where an insulated-wedge-split bushing is used in supporting the conductor. The bushing shown in the illustration is clamped in a yoke which rests on the top of the conduit, but similar noncombustible insulating bushings which require no yoke are manufactured for clamping one, 2 and 3 wires. These bushings are arranged to wedge down into the conduit bushings which are screwed on the upper ends of runs of tubing. Figure 1, II, and Fig. 2 show methods of supporting vertical conductors with clamps mounted in junction boxes. At II the insulating clamp consists merely of a 2-piece porcelain cleat attached to the back of the junction box with a couple of bolts. The insulation is not removed from the conductor, hence the clamp exerts its action by biting into the insulating material.

In Fig. 2, a method used for heavy conductors, the clamps are of metal and are soldered directly to and clamped over the conductors to be supported. As shown, the insulation must be removed from the conductor before the clamp is applied. Insulation is provided by the slate slab fastened in the back of the junction box. The minimum distance, D, between the 2 bare metal clamps of opposite polarity is determined by the voltage between the conductors and should be in accordance with the requirements of rule 69b, giving the spacing between live metal parts on panel boards.

Fig. 1, I, shows a method of supporting a conductor by deflecting it at an angle of not less than 90 deg. Tie wires may be used with this arrangement, but are frequently unnecessary.

Where supporting a number of conductors in a vertical run the usual practice is to arrange steel junction boxes at intervals and to install in each of these boxes a sufficient number of supports, of one of the types shown, for all of the conductors in the run. That is, it is unnecessary to use, as the illustrations indicate, a separate junction box for each conductor or pair of conductors.

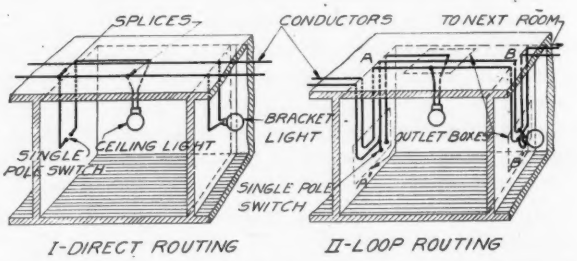


FIG. 4. COMPARISON OF LOOP AND DIRECT ROUTING METHODS

One large junction box inserted in the run can be arranged to enclose all of the supports for all of the conductors in the run.

Strain insulators and turn buckles are often used at the upper end of a vertical run to assume the vertical stress, but in addition the supports as described in the preceding paragraphs should also be used.

Where alternating-current conductors are in conduit all of the wire of a circuit—2 wires for a single-phase circuit or 3 wires for a 3-phase circuit—must be in the same tube. Where a single wire carrying alternating current is by itself in a conduit, eddy currents are induced in the tube which may, under certain conditions, heat it to a dangerous temperature. Furthermore, where a single alternating-current conductor is in an iron tube, the voltage drop in the circuit is materially increased because of the inductive drop due to the presence of the iron around the conductor. Where all of the conductors of the circuit are in the same tube, the tendency toward the production of eddy currents and toward the development of excessive inductive drops is practically eliminated.

All of the conductors of a direct-current system need not be in the same tube, because with direct currents the eddy currents and inductive effects above referred to do not exist. However, the liability of a change-over from

direct to alternating current always exists. There have been cases where in changing over direct-current systems, that were wired one conductor to a tube, to alternating-current systems, it was necessary to tear out and replace the whole installation because of the dangerous heating that developed in the ducts containing one wire when an attempt was made to use them in alternating-current service.

The number of conductors in any one conduit should be minimized in order to reduce the amount of combustible (insulating) material in the conduit and also because where a considerable number of wires is placed in one duct they may wedge, rendering withdrawal difficult or impossible.

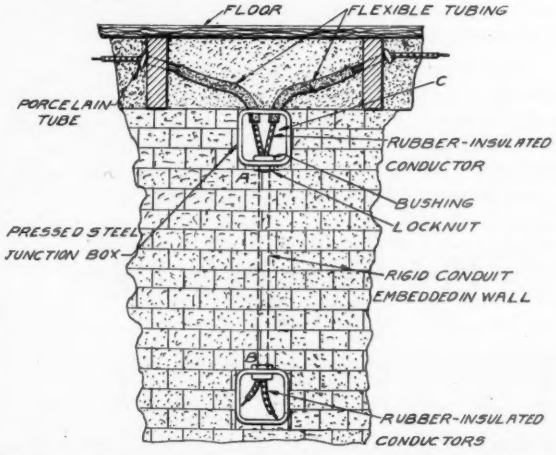


FIG. 5. SHOWING HOW KNOB AND TUBE WIRING IS JOINED TO CONDUIT WIRING

Conduit smaller than ½ in. nominal diameter should not be used. Number 14 wire (Rule 16A) is the smallest size permitted for wiring except in certain special cases. Experience has shown that pipe of ½ in. nominal diameter is the smallest that will permit the ready insertion and withdrawal of 2 or 3 No. 14 rubber-insulated conductors.

Installation of Conduit System

A CONDUIT SYSTEM must be continuous from outlet to outlet for 2 reasons. The first is to insure that the entire raceway or tunnel in which the wires are carried will have a strong metal casing which will protect the conductors against mechanical injury and localize a fire within the conduit system if one should start. The second is so that it will be certain that the conductors can be drawn into the conduit system and withdrawn from it at any time without damage or abrasion.

Every run of duct must terminate in an accessible steel outlet box in order to fulfill the requirements indicated above. Such an outlet box may be either a steel distribution cabinet, a steel switch box, a steel junction box or a fixture outlet box. Since the conductors must be without splices or taps in the conduit, all splices or taps must be made in these steel outlet boxes.

Loop routing of wiring is necessary in concealed conduit installations to satisfy the requirements that all splices be in accessible outlet boxes. In knob-and-tube or in open wiring, the conductors can ordinarily be laid out in accordance with a "direct routing" as suggested in Figs. 3, II, and 4, I. This is permissible, since in wiring in accordance with these methods, the splices or joints may be made at any convenient point. Figures 3, III, and 4, II, show how in conduit work it is necessary to "loop" from outlet to outlet. It is usually cheaper to loop between outlets than it would be to insert additional junction boxes in which splices could be made

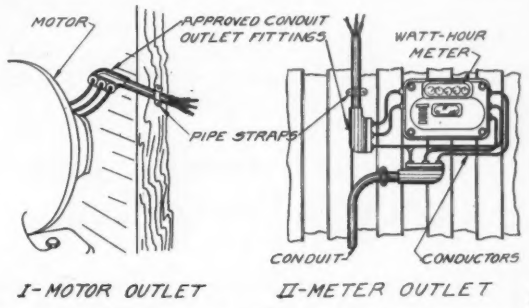


FIG. 6. APPLICATION OF APPROVED OUTLET FITTINGS

whereby the looping could be eliminated. This, however, is not always the case; for example, it might be more economical in the case shown in 4, II, to install junction boxes (near the ceiling, accessible from the room) at points A and B than to loop down as shown. If the junction boxes were installed, only one run of conduit would be required between A and A′ and B and B′; whereas, with the loop routing illustrated 2 conduit runs are necessary between A and A′ and B and B′.

Conduit runs must extend into steel boxes—it is not sufficient that they extend merely up to the boxes. For example, in Fig. 5 it would not be permissible for conduit length AB to extend from B to point A just outside of box C. The conduit must enter every box. If it does not enter, insertion and withdrawal of conductors will be difficult or impossible. Figure 5 also shows how knob-and-tube wiring may join conduit wiring. Flexible tubing must encase the knob-and-tube conductors from the last point of support and extend into the conduit outlet box to prevent the edges of the knock-out holes from abrading the insulation on the wires.

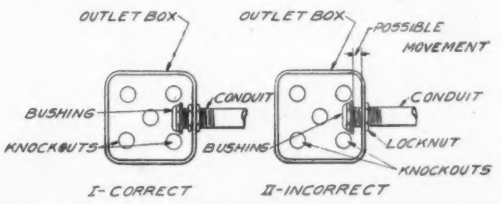


FIG. 7. CORRECT ARRANGEMENT OF LOCKNUTS

The components of a conduit system should be secured mechanically in position, that is, the tubing, outlet and junction boxes, must be securely supported. Pipe straps, held with nails or screws, may, as shown in Fig. 6, be used for supporting exposed conduit runs or concealed conduit runs in frame structures. Locknuts and bushings secure the conduit lengths in the outlet boxes as shown in Figs. 2 and 7. In fireproof buildings, the conduit runs are imbedded in the walls and partitions and are thereby rigidly supported, as are the outlet boxes. In frame structures, the outlet boxes are held

with nails or screws driven through holes provided for their reception into wooden supporting strips.

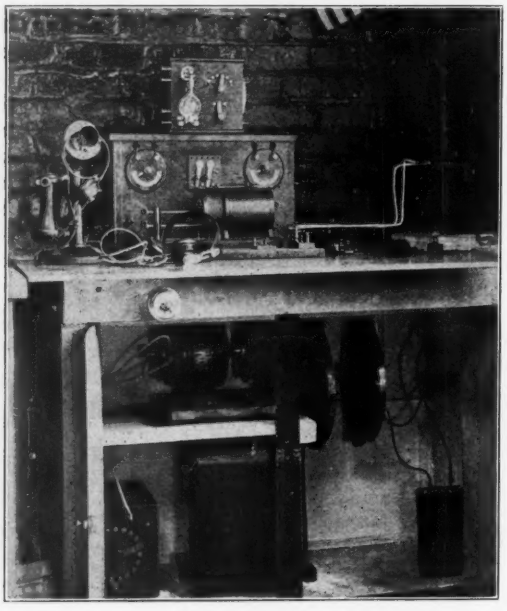
In placing locknuts on conduit ends, 2 should be used at the end of each run as shown in Fig. 7, I. If only one is used there is a possibility of the end of the tube shifting back and forth in the box as shown in Fig. 7, II, because ordinarily the bushing itself does not clamp down against the box side. Where vibration is present or where conditions are such that the shifting of the conduit is aggravated, the conductors carried within the duct may have their insulation abraded or they may be broken. (To be continued.)

Wireless Communication Between Power Plants

By W. Painter

THE use of wireless telegraphy has been successfully applied to power plants as an emergency means of communication between the various stations which tie up as one system.

The advantage of a wireless system is readily appreciated when one considers that severe weather conditions are apt to cause the telephone lines to go down with the power transmission lines. In such a case it is quite necessary to dispatch orders without delay; to call for relief, and arrange for load regulation.



POWER PLANT WIRELESS STATION

One company, which operates a number of power plants and substations in Illinois, installed complete wireless equipment at 2 of its largest plants. The smaller outlying plants now telephone their daily reports to one of these wireless-equipped plants, and this in turn relays—via wireless—the reports to the other station at which the system load-dispatcher is located. This daily communication serves as practice for the operators, and aids in keeping their instruments in adjustment.

Their sending and receiving equipment is located on the switchboard gallery, and the watch-electrician serves as wireless operator. The aerial is suspended between 2 stacks, which makes a convenient and favorable location.

The first installation in this particular plant was made 2 yr. ago, and little serious consideration was given to it. It was an experiment; but the company has recently ordered the apparatus necessary to equip its other stations, and also contemplates increasing the present wave length of 200 meters to 600 or 1600 meters, in which event they would cease to operate as amateur stations. The use of 600 meters would call for a commercial license, and operating with a 1600-meter wave requires a special government permit. The advantages of a large wave length would be: assurance of privacy and little or no interference from outside stations.

It is worthy of notice that there has been activity elsewhere along power plant wireless "lines." A public-utility corporation located in Georgia, and operating 4 power stations which are considerable distance apart, has provided wireless equipment at each plant, thus assuring complete inter-communication at all times.

Had Never Been Oiled

By E. C. Parham

THE smaller a motor or a generator, the more difficult it is to get high efficiency, because not only does the friction of the bearings and the brushes become a larger percentage of the total energy involved, but the energy required to force field magnetism across the air gap becomes relatively larger on account of the thickness of the air gap not decreasing in direct proportion to decrease in machine rating. Fortunately, machines of fractional horsepower rating have to do with a total energy that is so small and they are profitably used in so many applications that would be almost impracticable without them, that efficiency is a matter of secondary consideration.

A householder obtains considerable comfort from a small motor that drives a cooling fan, ventilating fan, water circulating or pumping outfit, sewing machine, washing machine, dough mixer, etc., and no question of efficiency is ever raised, nor should it be, because the health and labor-saving returns are out of all proportion to the cost. It is only necessary for trouble to discontinue any of these health giving conveniences, when there comes forth a prompt protest. It is comparatively easy for neglect to interfere with the operation of a small motor, for it generally means failure to oil the motor or its connected load, and friction is already a large part of the motor's duty.

A small single-phase motor applied to a reciprocating pump used for circulating hot water melted the friction metal shoes of its automatic clutch. The inspector who replaced them found it impossible to budge the pump by hand. The pump was stuck for want of oil and inquiry disclosed that no part of the outfit had ever received a drop of oil since its installation. The pump was then disassembled, cleaned, reassembled and oiled, after which even the housewife noticed the difference in operation.

Foreign Development in the Power Plant Field

TUNGSTEN FILAMENTS FOR ALTERNATING CURRENT; MAGNETIC TRANSFORMATIONS; NEW FLEXIBLE COUPLING; ALLOYS FOR TURBINE BLADES. BY J. H. BLAKEY

IN an article in the Elektrotechnische Zeitschrift, some instructions are given for the manufacture of tungsten filaments for use with the alternating current. With this current, the ordinary tungsten filament undergoes a change in its molecular structure, just as tantalum filaments do. There are displacements of the molecules, which arrange themselves sidewise with regard to the axis of the wire, so that the wire seems to be cut up into lengths which adhere only at their ends. This change of structure is caused by the vibration of the molecules under the action of the alternating current, and of course a breakage of the filament is the result.

The Auer Co. has taken out patents for an improved method of manufacture of the filament which overcomes this difficulty. It has been found that if the tungsten contains 0.02 per cent of phosphorus, this change of structure does not take place, and the ductility of the wire is not affected so long as this percentage of phosphorus is not increased. Another method is to add lime or some compound of calcium in the manufacture of the filament. To a mixture containing 8 per cent of nickel oxide and 92 per cent of tungsten a small amount of a solution of some calcium salt is added. When dry the mixture is reduced with hydrogen, and rods are then made and sintered* together. When the nickel has been volatilized, there remains a certain amount of calcium in the filament. This is said to give a wire which is not affected by the alternating current.

MAGNETIC TRANSFORMATIONS IN IRON AND STEEL

A GREAT MANY experimenters have observed that the magnetization curve in steel and iron becomes irregular at a point in the neighborhood of 392 deg. F. (200 deg. C.), and it has been concluded that the cementite contained in the metal must undergo magnetic transformation at this temperature. In order to verify this hypothesis and to determine exactly the critical temperature of this transformation, Messrs. Kotaro Honda and Hiromu Takogi have undertaken at the University of Tokyo a series of experiments with castings of various kinds. The results are given in a memoir addressed to the Iron and Steel Institute in England, and may be summarized as follows:

During the cooling of the casting the magnetic transformation of the cementite begins at 428 deg. F. (220 deg. C.), and when the casting is heated the transformation is entirely finished at this temperature. This is therefore the critical temperature sought. Previous experiments with steels had given the same result, so that it appears that the magnetic transformation of the constituents of the iron occurs at this temperature, which is much lower than the critical temperature of the iron itself. The authors conclude from this that the only carbide of iron existing in steels and castings at ordinary temperatures is cementite. The memoir also contains diagrams showing the curves of magnetic permeability of pure iron, produced electrolytically, at temperatures from 1544 to 1778 deg. F. (840 to 970 deg. C.).

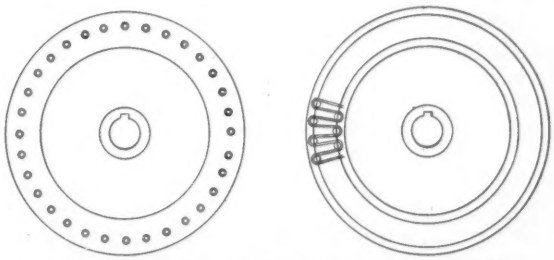
*"Sintering" is defined as the incomplete union into a solid mass of the particles of a powder heated so that softening but not perfect fusion of the mass occurs.

A NEW FLEXIBLE COUPLING

THE GERMAN firm of Eisenwerk Wulfel, of Hanover-Wulfel, is making a form of flexible coupling which at least has the merit of simplicity of construction. As will be seen by the accompanying diagram representing the 2 faces, these consist of a disk studded with steel pins, and the opposing disk with 2 concentric rows of pins; the two rows being connected by a ribbon of steel. These couplings are made in sizes up to 2 meters (6 ft. 6 in.) in diameter.

ALLOYS FOR HIGH-SPEED TURBINE BLADES

IN THE Journal of the English Institute of Metals, W. B. Parker has a paper on "Specifications for Alloys for High-Speed Superheated Steam Turbine Blades."



THE EISENWERK WULFEL FLEXIBLE COUPLING

After describing the effects of the steam on the material now generally in use for turbine blades, at pressures as high as 400 lb. per sq. in., and at temperatures up to 750 deg. F. (399 deg. C.), he recommends the use of copper-aluminum-nickel alloys for this purpose, as a result of a study of the micro-structure and erosion of these alloys and others now commonly used.

STANDARDIZATION in gas engine manufacture, which will be one of the chief topics considered at the meeting of the National Gas Engine Association in Chicago, June 27-29, does not mean that all makes will be the same, but that many of the things used in manufacture will be of the same outside dimensions. An instance of the benefit of standards is the carbureter, connection sizes and spark-plug openings in automobiles so that practically any make of carbureter of proper size or spark-plug will fit any make of car. This simplifies securing repairs and supplies.

In the work of the N. G. E. A., automobile standards will be advocated where they meet the needs of the stationary engine; where they do not, effort will be made to work out a size, style or arrangement of part or attachment that may be used generally to best advantage. An instance is the ignition magneto. Almost any magneto may be applied to any engine without changing the design of either. There is no compulsion, however, and any engine manufacturer who prefers may use a special design of magneto or special method of attachment. The same will be true of any other details which may be standardized.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Gas Producer Control--II*

THERMOSTAT ON AIR SUPPLY, CORRECT TEMPERATURE, RESERVE CAPACITY. BY REGINALD TRAUTSCHOLD

CONTROL of the temperature of the saturated air should advisably be by automatic means, such as a thermostat situated between the "saturator" and the draft connection to the producer, in producers which employ the engine jacket water or other exterior source for the water for saturating the air; or similar regulation of the temperature of the jacket water within the producer shell, in producers which so saturate their air supply. This will accurately and automatically control the temperature of the saturated air supply. It must not be forgotten, however, that there is but one efficient temperature for this saturated air supply for a particular producer, operating on a given quality of coal, and once this is ascertained by experiment the saturated air should be maintained at this one temperature just as long as the particular grade of coal is used, regardless of the load.

Should change be made in the kind of coal or should it be fed to the producer in a different condition, for instance, after it has been subjected to unusual weather conditions, the advisable temperature for the saturated air supply may change; this should again be ascertained and the regulation of the thermostat possibly altered. In fact, an occasional test for this advisable temperature is to be highly recommended.

TEMPERATURE DETERMINATION

AS PREVIOUSLY STATED, this temperature should be ascertained by experiment, but the regulation is so sensitive that a temperature approximately correct should first be adopted, and the experiments consist simply in varying this temperature 1 or 2 degrees at a time in the search for the best operating conditions. This approximately correct temperature is usually known to the producer manufacturer and the operator advised thereof. Occasionally, however, this is not done, and it remains for the operator to try various temperatures or to calculate the right one theoretically. Calculated temperatures are not sufficiently reliable to be used without confirmation by actual testing, but they are of value as a basis from which to experiment. Many arbitrary assumptions have to be made, of course, and this tends to introduce error into the results.

In the first place, the volatile constituents of the coal may be considered as driven off by the heat developed in the producer, so that the only function of the saturated air supply is to act on the carbon constituent of the fuel. The theoretical amount of air required to supply the oxygen for the positive reaction of the producer is about 11.6 lb. per pound of carbon consumed, or for all practical purposes 12 lb. Obviously only half this amount is required for the formation of carbon monoxide, the desired result.

In the positive reaction, which forms carbon dioxide, there are liberated about 14,544 B.t.u. per pound of carbon consumed; in the negative reaction, the reduction of the carbon dioxide to carbon monoxide, about 5642 B.t.u. are absorbed per pound of carbon; so that the net heat generated from the two reactions is about 8900 B.t.u. per pound of carbon, or, for practical purposes, per pound of coal consumed. It is this amount of heat which must be cared for.

The average weight of the gases resulting from one pound of coal as fed to the producer amounts to from 7 to 8 lb., and the proportion of carbon monoxide contained in these gases is about 25 per cent. About 6 lb. of gases other than those resulting from the combination of carbon and oxygen, have to be raised to the mean temperature in the producer, which is in the neighborhood of 3500 deg. F. (1950 deg. C.). These gases have a specific heat of about 0.25, so that about 4800 B.t.u. of the net heat generated is thus absorbed. The producer jackets absorb a considerable amount of heat and there is, of course, a certain amount which escapes through radiation. A conservative proportion to place on these two heat losses is about 30 per cent of the net heat generated, or 2760 B.t.u. per pound of coal consumed. The net amount of surplus heat remaining to be cared for is then something like 1430 B.t.u. for each pound of coal treated in the producer.

PRODUCER RESERVE CAPACITY

CARING FOR THIS last proportion of surplus heat introduces the reserve capacity of the producer,—its ability to meet unusual demands for gas. This reserve capacity also fixes the size of the producer best suited for a particular installation. There is nothing to gain, however, by making this reserve greater than 50 or 60 per cent, if the producer is suitably proportioned to the work demanded of it. The specific heat of the fuel bed, like that of the gases generated, is close to 0.25, so that the heat required to raise 0.6 lb. of surplus fuel to the producer temperature, 3500 deg. F. (1950 deg. C.), would be about 480 B.t.u., leaving but about 950 B.t.u. per pound of coal consumed to be cared for by the water vapor. The surplus fuel is maintained in a condition

*Continued from page 460, May 15 issue.

bordering on incandescence, but performs no active work unless the demand for gas is increased, serving simply as a sensitive control for the activity of the producer.

Long periods of constant load reduce the necessity for this producer reserve, in fact, the reserve may even tend to reduce the efficiency of the producer under such conditions by unduly elevating the temperature of the producer, but this is compensated in part by increased radiation and greater surrender of heat to the jackets, so that it is advisable to figure on this reserve capacity in the ordinary installation.

The cooling capacity of water vapor supplied the producer may be taken as about 1600 B.t.u. per pound, as the specific heat of superheated steam, the actual condition of the water in the saturated air on coming in contact with the incandescent fuel bed, is 0.481, and the temperature rise is some 3500 deg.; hence 0.6 lb. of water vapor is necessary to care for the surplus 950 B.t.u. of heat. As about 6 lb. of air are supplied for each pound of fuel consumed by the producer, each pound of saturated air should contain 0.1 lb. of water vapor.

Saturated air at 127 deg. F. (53 deg. C.) contains just about this amount, so this temperature is about the correct one for which to set the thermostat, provided that the size of producer is correct for the work demanded of it. A producer which is over size will require less water vapor, and one which has not as great reserve capacity, more water vapor. Saturated air at 140 deg. F. (60 deg. C.) contains about 50 per cent more water vapor than saturated air at 127 deg., so the careful adjustment of the thermostat is very important. The correct temperature of the saturated air supply nearly always lies between 125 and 150 deg. F. (52 and 65 deg. C.), but between these limits there is a difference of 223 per cent in the amount of water vapor carried in saturated air.

Either too much or too little water vapor, the air supply too hot or not hot enough, produces an excess of carbon dioxide in the producer gas; in the first case, on account of excess cooling of the fuel bed, which tends to arrest the negative reaction, which changes CO_2 to CO, and eventually results in extinguishing the fire; the second instance, on account of insufficient cooling of the fuel bed, results in the increase of the positive reaction, forming CO_2, and corresponding decrease of the subsequent reducing reaction, tending to burn out the producer. The latter condition is also shown by an increase in the fuel bed temperature.

Correct water supply, the controlling factor in the temperature of the saturated air, is then accurately fixed by the condition of coolest fuel bed with minimum allowable proportion of carbon dioxide in the delivered gas. This allowable proportion of carbon dioxide is in the neighborhood of 5 per cent. These co-related conditions greatly simplify the experiments required for ascertaining the correct temperature for the saturated air supply. This is, then, the maximum temperature which can be maintained in the producer without increasing the proportion of carbon dioxide in the producer gas beyond 5 per cent. (To be continued.)

DURING 1915, 36,648,466 bbl. of petroleum were used on locomotives in the United States, an increase of 5,555,200 bbl. over that of 1914.

Some Gas Engine Operating Experiences

BY HAWLEY L. SCOTT

I SHALL not readily forget the time when I had the job of repairing 2 1100-hp. 4 cycle double-acting twin-tandem gas engines, which had been in use for a number of years. The piston rods were made up of a long rod which extended through both cylinders; over these rods were the 2 pistons and 3 sleeves.

In Fig. 1 is shown a section of the complete rod.

Before trying to take these rods apart, the sleeves and pistons had been filled with muriatic acid for several days, but it did very little good. The scale on the rod itself was no hindrance to us; it was the scale on the inside of the sleeve. This was about ¼ in. thick and about as hard as concrete.

As the sleeves fit pretty close in passing over the swells on the rod, you can see we had something to do to get them off. We tried force in the form of 2 25-ton jacks, then scrapers on rods which we reached into the sleeves, and wires placed inside of the sleeves on which we rolled the sleeve around, but to no avail.

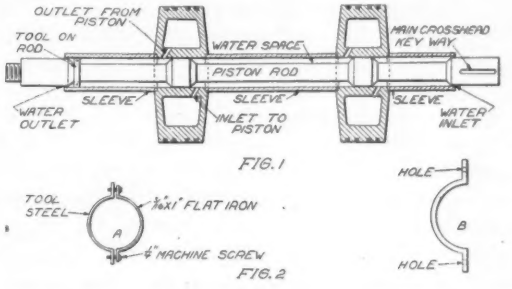


FIG. 1. GAS ENGINE PISTON ROD COMPLETE WITH PISTON AND SLEEVES

FIG. 2. SCRAPER FOR REMOVAL OF SCALE

Finally the idea came to me that a tool or cutter of some kind placed on the rod could be made to bore the scale out.

Figure 2 shows what we made. A piece of ¾-in. tool steel was flattened and bent as shown at B, a piece of flat iron was bent the same except the ends were not allowed to project as far.

Holes were drilled at the ends as shown and as there was only 9/16 in. of room for the cutter, we drilled the holes as close to the circle as possible, those in the steel 5/16 in. and those in the iron tapped out ¼ in. The ends of the steel were ground to the proper length and then both pieces fastened together by machine screws at the point on the rod shown in Fig. 1.

A clamp was placed on sleeve 1 and a couple of pieces of board nailed on for levers.

With 2 men turning the sleeve and one slowly forcing it ahead, we managed to bore out the scale. It was a hard, slow job, but as there was only one sleeve in the dozen that was scaled so very badly, it might have been worse.

I have seen big engines run with some of the chambers missing all the time, when it would be discovered

that a leaky air inlet pipe, underground, of course, had let in water enough to be drawn up into the combustion chambers. The only remedy I ever saw used until time allowed the air pipe to be repaired, was to apply a hand pump.

Another source of bother in some plants is the drains where the jacket water has to be used in fairly large quantities. Some drains never are large enough, while others may be just large enough at first, but by the time they have a heavy coat of scale the whole length, the engineer is likely to wish the man who advised that size pipe had the job of caring for the engine.

Natural Gas Ass'n Convention

AT THE meeting held in Pittsburgh May 15 to 18, some 1250 were registered as in attendance from every natural gas region in the country. A large and well arranged exhibit was displayed, including natural gas apparatus, machinery for well construction and operation and for power plants.

Interesting papers and committee reports were considered at the sessions, which were mingled with visits to the exhibit hall and social events. Among the subjects considered were Conservation of Natural Gas, Welding of Gas Mains, Measurement of High Pressure Gas, Obtaining Gasoline from Natural Gas, and Group Insurance. It was predicted that a revenue of $19,000,000 a year will be derived by the gas companies from production of gasoline from natural gas by absorption methods, an amount that formerly was wasted until the possibility of thus producing gasoline was discovered.

New officers elected were Joseph F. Guffey, Philadelphia, president; G. P. Braden, Tulsa, Okla., vice-president; T. C. Jones, Delaware, O., secretary-treasurer; directors, Arthur Booth, Pittsburgh; E. P. Grosscup, Charleston, W. Va.; B. C. Oliphant, Buffalo; J. C. Duffield, London, Ont.; Alfred Hurlburt, Kansas City, Mo., and O. K. Shannon, Ft. Worth, Tex. Buffalo was selected as the meeting place for 1917.

Directors of the Natural Gas Supply Men chosen were, David O. Holbrook, president; R. A. McKinney, Wm. K. Patterson, Wm. K. Hughes, L. F. Hamilton and F. W. Miner.

Among the exhibitors of power plant machinery were: Bessemer Gas Engine Co.; The Borden Co.; The Bristol Co.; Builders Iron Foundry; Chaplin Fulton Mfg. Co.; Columbian Rope Co.; C. & G. Cooper Co.; Fairbanks, Morse & Co.; Foxboro Instrument Co.; Garlock Packing Co.; B. F. Goodrich Rubber Co.; Hoover, Owens, Rentschler Co.; Ingersoll-Rand Co.; Jarecki Mfg. Co.; A. Leschen & Sons Rope Co.; Ludlow Valve Mfg. Co.; Manhattan Rubber Mfg. Co.; Mark Mfg. Co.; H. Mueller Mfg. Co.; National Transit Pump & Machine Co.; National Tube Co.; New York Belting & Packing Co.; Pittsburgh Meter Co.; Pittsburgh Valve & Fittings Co.; Pittsburgh Valve Foundry & Construction Co.; Pratt & Cady Co., Inc.; Revere Rubber Co.; John A. Roebling's Sons Co.; Schaeffer & Budenberg Mfg. Co.; Snow Steam Pump Works; Superior Gas Engine Co.; Tate Jones & Co., Inc.; Toledo Pipe Threading Machine Co.; Westinghouse Machine Co.

Government Positions

PRACTICAL INFORMATION ON SECURING GOVERNMENT POSITIONS AND OTHER INCIDENTAL INFORMATION. BY A. P. CONNOR

SOME engineers say they would not care for a position in the government and others say they would, but, as a matter of fact, these positions are usually very welcome when offered and the great majority are usually in no hurry to give them up. The writer has seen many indications of the high regard in which such positions are held, even by those who apparently (by their words) are dissatisfied with the conditions, and there are many instances that the writer could cite where government employes have resigned to improve their position in private life, that later made efforts and found means to return to their old positions, even at a lower salary. The reasons for this are that in general the life is easier, that is, has less worry in that the superiors cannot so easily or readily dispose of a man even if undesirable, and for this and other reasons the position is more or less permanent. This knowledge of the greater security of the position has a substantial effect on a person's life and general satisfaction. The salary of government positions is usually higher in the matter of engineers' positions than that of the average private concern employing engineers, although the writer will not say that he considers either as high as they should be, considering the requirements. The hours of employment are usually definite and as a rule less than those of engineers in private plants, and government positions usually carry with them a substantial vacation with pay. The position of an engineer in a government institution also carries with it prestige and the supervision of a relatively large number of employes and apparatus.

CLASSIFICATION OF GOVERNMENT POSITIONS

GOVERNMENT POSITIONS may be divided into 2 general classes, those of the State and the Federal Government. In the State, positions for engineers are found in all the State institutions and generally in the office buildings rented or used by the State. They may also be found on various examining or inspection Boards as well as for special investigations. The reader may find out what these are for his own State by keeping in touch with the legislation as it is passed in the matter. The various institutions of the State are Hospitals, Asylums, State Buildings for its legislature, the Departments and the Governor, Pumping Stations, Jails and Prisons and the Court Houses. Sometimes States have boats and railroads which, of course, would add to the positions.

In the Federal Government, positions may be found in similar institutions, and also in the Post Offices, Custom Houses, Navy Yards, and Immigration Stations. These positions are usually in the Treasury, Labor, Navy Department and Department of Justice. The Interstate Commerce Commission has a number of special positions, such as boiler inspectors. The Reclamation Service require engineers on all its power projects and other branches of the Interior Department use engineers, such as in the Indian Service. There are also positions in the Panama Canal, Philippine Islands, and other Government reservations, including Alaska, etc.

To find out about these positions is not always an easy matter; but in general, the Civil Service Examination lists and writing to the Department heads will give general information concerning them. A list of these positions and how each is obtained cannot be given at this time in this article, although the writer has no objection to aiding any of the readers that will request specific information in the matter through Practical Engineer.

How Positions Are Obtained

In general, State and Federal positions are obtained in 3 ways, Civil Service certification, Executive Order and political influence or its equal. Civil Service certification is usually derived from the results of an examination for the position. This examination may be public or private. It is usually private when a particular class or individual in the Service is desired in a special position. It is public when the law requires it specifically or for other reasons. It is not necessary, however, that an examination be taken to cause certification and appointment for a Civil Service position, but the mere filing of the application properly filled out will sometimes obtain it for an applicant, especially if there is a hurry to fill the position, as in case of emergency or where the position is of a temporary character.

Executive orders are appointments made directly by the President or Governor, and somewhat arbitrarily appoint a person to a specific position whether anyone else wishes it or not. They are, however, usually made for special reasons, and particularly to return a past employe back to his old position at the recommendation of his superiors (after his personal application to them), especially if these superiors have some special interest in him. Political influence is not without merit in such a case.

Political influence obtains practically all the positions that are not segregated under the previous headings. It is usually the reward for substantial voting effects produced by an individual or his substantial contribution to the political fund. The majority of the best positions are obtained through its means. They are, however, very often dependent on the duration of the term of the "influence" that brought about the filling of the position, or on the continuation of the political faith in power. In a number of cases that the writer has known the holders of certain positions in a certain Government station suddenly changed their political affiliations when the Republican party suffered in the last Presidential election, and not by any means to an intermediate party, such as the Progressives, but to the Democrats, and there were engineers in these cases. These engineers are still holding their positions, and while there may be some question as to the propriety of their action, there is at least none as to the results. These facts are mentioned so that the readers who have certain positions in mind, may be conversant with the conditions and be in a position to counteract or prepare for them. In the matter of political positions voting power is practically supreme, and money comes second. At the same time, a certain amount of judgment is usually necessary in handling such a line of action, and there is apt to be competition.

Civil Service Examinations

Civil Service Examinations, especially in the Federal service, are conducted with a very great degree of fairness. Their decisions and actions may at times be painted with a certain amount of stiffness, but that is an inherent feature of all institutions that have no great inducement to promote progress or efficiency, and especially when financial or economical success is not involved. The examinations are conducted with great uniformity and from the answers given is derived the percentage of the applicant.

The application is the first part of the Civil Service procedure, and consists of a printed form arranged with questions for the applicant to answer in his own handwriting. These answers are somewhat formal, but a great amount of attention is paid to them at the present time. The answers to the "experience" questions should be written fully, especially on the lines on which the position hinges. It is best to answer such questions on a separate slip of paper and after sufficient correction rewrite them on the form so that they will appear in proper shape. The writing should be done with regard to legibility, and in ink. Mistakes in spelling should be avoided and in other ways the appearance of the person of the applicant should be made good in the form, which is practically the photograph of the applicant's appearance and qualifications as they appear to the examiner.

Follow the instructions of the form, in the matter of the oaths and vouchers, carefully, because in these parts a great many of the mistakes that cause the return of the application to the applicants are made. These mistakes can be avoided if the instructions are followed, and these are made as clear as possible.

The Examination

It seems hardly necessary to advise that the applicant should read up as much as possible before an examination in order to refresh his memory and to get other desirable information required. This should be done, but not in such a manner as to leave the applicant tired and sleepy on the day of the examination.

On the day of the examination, the applicant should have pen, pencils, rubber, ink, and any other material desirable for it, and should have some light lunch in his pocket, as the examination time may last about 5 or 6 hr. Select, if possible, a seat where the light is good, such as near a window, but not where the sun can shine on him. He should be careful of drafts, such as near hall doors and any other such inconveniences as may be apparent. All such matters affect the ability to work at an examination and the less there are of them to distract, the better it will be for the applicant, and he can make them less by properly selecting his seat.

The first day is usually spent in filling up forms on matter already put in the original application, or in waiting to get the examination number and other matters straightened out, and there is much noise and confusion, together with drafts from open doors, to add to the inconvenience of everybody. After matters are settled, and the engineer applicants are at work at some mental problems, the inspector in charge of the room will perhaps give some dictation to other applicants for other positions and his talking is usually disturbing to applicants answering technical questions. If the applicant is

prepared for this condition, however, he can reduce its effects greatly by filling his ears with cotton. After the first day, the room becomes comparatively quiet and the applicant can work with comparative ease.

The answering of the examination questions is important, and it is believed that the following hints will assist in the matter. First see that the number and the subject is properly put at the place assigned for it on the answering sheets, also put the page number of the sheet on it. The second thing to do is to put down the number of the question about to be answered. Then write the answer carefully, but not slowly. Read the answer over afterward and correct it where necessary. Do all the answers in like manner, and leave at least 2 lines space between each 2 answers; this is to help the "looks" and to permit the insertion of more details, if it is found later that there is some other point that should be added to the answer. The examination paper is supplied in such quantities as the applicant may desire, and it therefore should not be economized upon at the expense of the "looks" of the answers. If a sheet becomes dirty from blots, etc., rewrite it.

After looking over the questions, answer every one that you have to, even if not sure of the correctness of the answer. It will at least stand a chance of getting something if partly correct, whereas for an unanswered question no marks can be given. Don't get discouraged at any question nor stop thinking too long about any question, but start writing on the sheet of paper and the thoughts will tend to follow automatically. If you cannot answer a question from a theoretical standpoint, answer it as far as possible from a practical standpoint. Give examples to illustrate answers as far as possible. In writing answers, classify each into definite parts, starting in with a repetition of the question, then following with an explanation, then the advantages, then the example, and so on as the case may require.

After completing the answering of all the questions, read over all your papers and check them up for all kinds of mistakes or omissions, see that each sheet is properly numbered and so on. Then look up and see how much time is left; if there is quite a substantial amount, go over the questions and see if you have answered the questions, not WHAT YOU THOUGHT were the questions, using every effort to get your examination papers as good as possible.

After the examination papers are acted upon, which takes anywhere from 2 weeks to 6 months, you will get your rating and your relative position on the list. If your rating is below a passing grade but quite close to it, it would be well to ask for re-examination of yours, and this may bring you up higher. If you have passed, you become eligible for any position that may arise in the matter. If you are first, you should be appointed, but the head of the Bureau can select any one of the first three every time he wishes to fill a position. If there are many positions the chances of getting one are greater to the applicants not so high up. Appointees are usually appointed at the lowest salary of the position. The first appointment is probationary for 3 or 6 months; after this an absolute appointment is given.

General

The conditions under which an appointee will work will depend on many things, but one of the main controlling features is that much will depend on his ability to keep on the good side of his superiors, whether they are technical men or not. The same feature is common to positions in private life, but in the latter case the man that is the best business proposition is the most satisfactory to his superiors. This may or may not be the case in the Government, depending on who is head of the various bureaus. It is more important to the Government that the work should go along smoothly, rather than at low cost.

Settling Water Works Value

LONG and costly litigation has been avoided and a precedent has been set by the city of Bath, Maine, by the manner in which it has acquired the water works system formerly owned by the Maine Water Co. By mutual agreement between the Bath Water District and the company, the question of price was referred to 2 engineers as arbitrators, with power to choose a third arbitrator. Frederic H. Fay, of Boston, represented the Water District, and William B. Getchell, of Augusta, Maine, represented the water company, and they were able to reach a satisfactory agreement promptly without the necessity of calling in a third arbitrator.

Not only was the cost of litigation saved, but the price agreed upon was $19,507 less than the reproduction cost of the plant. In previous cases where litigation has figured prominently, the price has averaged about 1½ times the reproduction cost.

Trustees of the Water District and the Maine Water Co. first agreed to submit the question of reproduction cost of the physical plant, depreciation and water rights, to the engineers on both sides; an agreement upon any one or all of these points to be binding on both parties. After a 3-days' conference, the engineers agreed on a reproduction cost of $544,491, and $5000 as the value of the water rights. The rights of way, tools and supplies totaled $14,516, making a total of $564,007. They failed to agree, however, in the depreciation of the plant. The question of going value was not considered.

At the conclusion of this conference, the counsel for the District made a novel suggestion to the water company—that the entire matter of the purchase price for the plant, property rights and franchises be left to the two arbitrators named with the proviso that in the case Messrs. Fay and Getchell failed to come to an agreement they should select a third arbitrator not an engineer. The decision of these arbitrators to be final, binding upon both parties. The award of these engineers was $539,500.

A careful estimate shows that the actual saving in litigation expense is at least $40,000 for each party. The trustees are perfectly satisfied with the result, and the water company considers the price to be paid a fair one. The entire transaction furnishes an excellent instance of up-to-date efficiency and demonstrates the practicability of this method of settlement.

U. S. Civil Service Commission announces examinations, July 5 and 6, for assistant inspector of weights and measures, to fill vacancies in the Bureau of Standards, Department of Commerce, for service in the field; and chemist, to fill 2 vacancies in the Ordnance Department, Navy Yard, Washington, D. C. Apply for Form 1312, stating the title of the examination desired.

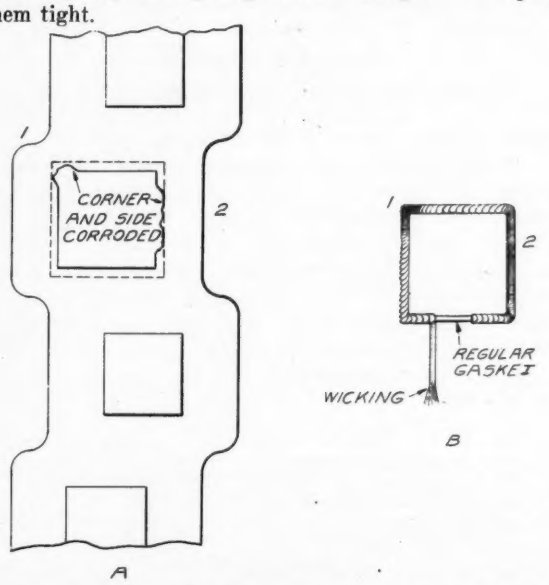
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Gaskets for B & W Boilers

NEARLY EVERY plant that is equipped with water-tube, sectional, header type boilers, that have seen a few years of hard service, has its troubles with leaky handhole gaskets, and gaskets blowing out, so badly that putting out fires is a necessity, and we would all welcome a cure that would eliminate this extra work, loss of time and coal.

When the handhole plate seats of the headers, uprights, and cross-boxes become worn, corroded, or deteriorated at the sides, corners, and edges, or the holes distorted from excessive setting up of the plate, stud, and nut, they start giving trouble in regard to keeping them tight.



DEFECTIVE HANDHOLE AND GASKET MADE ESPECIALLY FOR USE HERE

The following is the manner in which I treat them. When a plate hole of a header has become enlarged or distorted so that a handhole plate fits loosely or poorly, make a special gasket by taking one of the regular gaskets that fit the plate and wrap or wind this with some lamp wicking, soaked in thick red lead (this wicking is the kind used in lard oil lights), use as many strands as considered necessary to make the gasket fill in the space between plate edges and the header hole edges. Place the plate in the hole carefully and set up hard and tight. When the boiler is lighted off, follow up on the plate to take up the slack caused by expansion.

When a seat of a handhole is worn, or deteriorated away at the side or corner, as shown in the sketch, use a gasket made in the same manner as described, but covered with litharge or Smooth-On cement, in good quantity, especially at that part of the seat where corroded, put this gasket on a new plate, spread on an extra coat of the mixture, and as quickly and carefully as possible place it in the poor handhole and set up hard and tight. The writer has a large number of poor header handhole seats, treated as above, that are holding tight at 265 lb. in boilers doing hard service.

A great deal of trouble with leaky handhole plates can be avoided if careful attention is given to the cleaning of the seats of both the plates and the header handhole, a small piece of old gasket or particles of rust left on the seats when a new gasket is put on are the causes of many blow-outs. When plates are removed for the cleaning of boilers, before they are replaced the threads of the plate stud should be well oiled and the nut made to run free on it by hand; this permits the easy adjustment of the plates in the hole to divide the space around the plate evenly. If a nut goes on a stud hard and the use of a wrench is necessary in tightening it up, you are liable to work the plate around in the hole just enough to make the gasket fit or lie poorly on the seat; if a gasket does not lie flat on its seat when drawn up, it will not make up tight.

A great deal of deterioration of fronts of headers, uprights and boiler parts can be prevented by scaling clean and free from rust, and when the boiler is lighted off and fairly hot, apply a coating of crude oil; 2 coats gives fine results, lasting about 3 months, showing a gloss finish. There are other mixtures that give satisfaction: Red lead mixed with kerosene, asphaltum paint, graphite mixed with equal parts of kerosene and cylinder oil. Any of these applied while the boiler is hot will preserve it against rust for a period of 3 to 4 mo., when another such treatment will be needed. C. H. WILLEY

Steel Wedges in Foundations

THE WRITER has frequently noticed the steel wedges (commonly used for leveling a piece of machinery previous to the pouring of cement grouting) are left in place after the foundation has set. The practice has been defended by engineers of undoubted ability and standing. As the grouting naturally shrinks away from the bed plate as it dries out, the weight is carried by the wedges; the tightening of foundation bolts tends to spring the bed plate more or less and after the apparatus has worked a while there is a tendency for it to rock on foundation. It will be found that engine designers leave sufficient surface in contact with foundation to allow of weight being effectively and evenly supported. If wedges are removed before grouting becomes hard the holes filled in with stiff cement, when founda-

tion bolts are well set up, a permanent, satisfactory job will result. As the practice of leaving the wedges in place is more or less common, it would be of interest to many to learn what is claimed for this method and whether it is approved by modern engine builders.

FRANK H. WILLIAMS.

Record Form for Small Plant

RECENTLY, the Public Utilities Commission of Illinois has required all light and power companies to keep a complete station record. Most of the smaller companies had never kept any records of this kind, and these were compelled to devise some means of complying with this ruling. To meet this requirement, I devised the following sheet, which contains all the information required in this particular case, and which could be altered slightly to meet the requirements of any small company.

CONVENIENT FORM FOR RECORD OF SMALL PLANT OPERATION

FEB. 1916	VOLTS	START AMP	VOLTS	6 P.M. AMP	VOLTS	9 P.M. AMP	VOLTS	6 P.M. AMP	TIMES OF READINGS
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									INSTRUMENT READINGS
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									

FEB. 1916	STATION STARTING TIME	STATION STOPPING TIME	STREET CIRCUITS NORTH ON	NORTH OFF	SOUTH ON	SOUTH OFF	REMARKS AND INTERRUPTIONS
1	6 P.M.	6 A.M.	9 P.M.	1 A.M.			
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							STATION OPERATIONS
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							

The date spaces on both parts of the sheet are made exactly the same size; this is necessary and also the arrangement of the sheet illustrated is necessary in order to use a cover to keep the sheet clean. I made a tracing of this sheet, leaving the month and year space and also the time spaces vacant so that the particular months, years and times could be written in to suit any time later. I print from this tracing onto black and white print paper, which makes a neat job and is as good as a printed record, and they can be made as needed.

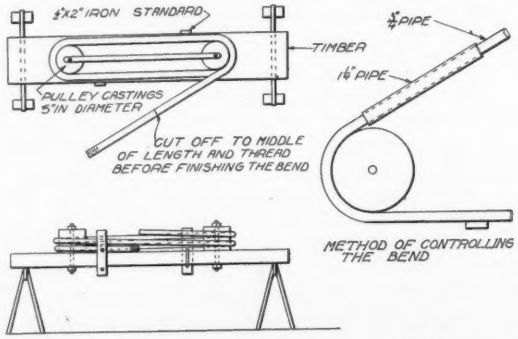
To keep this record clean, which is hard to do around a power house, where the one man does the firing and runs the engine too, I made a sliding frame to cover the sheet. The frame was made ½ in. longer than the sheet and covered on the bottom side with 0.015-in. transparent celluloid. The record sheet was then fastened with thumb tacks to the desk and the sliding frame placed over it, the record being to the left end of the frame. Then a slot was marked out on both parts of the record, on the celluloid, so the slot would leave an opening full length for the first day of the month on both parts of the record. This slot leaves room to write all the items for one night's record. Then as the month progresses, just move the cover to the left to the proper date. Making the cover longer than the sheet always gives a full view of the record at any time in the month without removing the cover. I have been using this for several months and find no fault with it.

GUY G. LOGAN.

Making a Pipe Coil

WE HAD USE, the other day, for a coil of ¾-in. pipe 4 ft. long, 10 in. wide and 20 pipes high; herewith is a sketch of the rig we used in making the coil. We bent up lengths of pipe and connected them together with unions; right and left couplings would have been better, but we had no left-hand die. We controlled the bend by slipping a piece of 1¼-in. pipe over the ¾, and making a little of the bend at a time, drawing the 1¼ pipe back as the bend progressed. We did not fill the pipes with anything to prevent flattening; neither did we pay any attention to the location of the weld.

The job was successful in that the pipe did not flatten nor were there any leaks.


¾"x2" IRON STANDARD
¾" PIPE
TIMBER
16" PIPE
PULLEY CASTINGS 5"IN DIAMETER
CUT OFF TO MIDDLE OF LENGTH AND THREAD BEFORE FINISHING THE BEND
METHOD OF CONTROLLING THE BEND

METHOD OF BENDING PIPE FOR A PIPE COIL

I neglected to say that the bending was done cold. In starting to bend up a length of pipe we located the end in the middle of one side, and in finishing bending the length we made the end come in the same location, as shown by the sketch; this left the sections so they would couple up into a symmetrical coil. A good universal pipe bender would be handy as well as saving many fittings and making a better job, but you seldom see one around the mills.

J. O. BENEFIEL.

Running a Disabled Compound Engine

SOME TIME AGO I was asked to look at a cross compound engine that had met with an accident to the low-pressure piston, with the object of keeping the engine in operation.

An investigation revealed the fact that the engine exhausted into a surface condenser, that the piping was not arranged to run the high-pressure side condensing, bypassing the low pressure, and that there was no atmospheric exhaust.

It was decided to take down the hook rods between the rocker arms and the valve motion and secure the steam and exhaust valves wide open at each end of the low-pressure cylinder.

A cast-iron plate or circular strap was found and faced up in the lathe. The low-pressure stuffing-box gland was used as a templet and the holes for the gland studs transferred to the iron plate and then drilled.

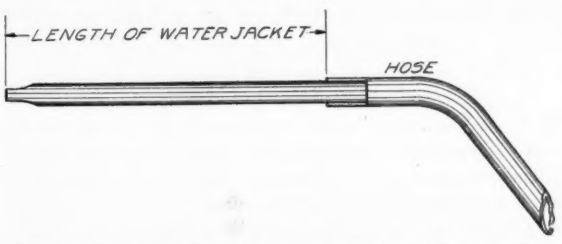
A wooden plug was turned to fit the stuffing-box, then wet, to cause it to swell, and driven home. A gasket was cut to go between the iron plate and gland when these were secured in place.

The engine was started and with a vacuum of 25 in. the high-pressure side carried about 80 per cent of the usual load for over a week until the new piston arrived.

RECEIVER.

Washing Air Compressor Water Jacket

I HAVE FOUND it a good idea, in washing out the water jacket of an air compressor, to use a long nozzle made of ¼ or ½-in. pipe pointed at the end and as long as the water jacket, as shown in the illustration. In this way, the water space at the front head is much better cleaned of sediment and mud which accumulates there. With this nozzle you can play the water directly on the parts of the back head, which is not affected where a short nozzle is used.



NOZZLE FOR WASHING AIR COMPRESSOR WATER JACKET

This arrangement is especially good where there is not much water pressure, as I have run water jackets which were nearly clogged up with mud, due to the fact that there was not water pressure enough to wash this out.

I believe the water jackets on some air compressors are not kept as clean as they should be. This is bad practice and may cause trouble some day. It should be inspected occasionally and washed out as often as found necessary instead of waiting until nearly all water space is clogged up with mud or other matter.

H. A. JAHNKE.

Utilizing an Odd Corner for Transformers

AN ECONOMICAL installation of transformers for lighting and power service was made in an unused corner of a factory yard, as illustrated herewith, the photograph being taken, however, before the leads were properly supported. The building is about 9 ft. from the sidewalk, and the transformers were placed on the ground in a triangular plot formed by the sidewalk and an intersecting street, with an iron fence about 6 ft. high to safeguard passersby. The primary leads are run from the underground cable ducts to the local central station to a switch box mounted on the factory outer wall and are then run on pin type insulators attached with axes horizontal along the wall to the transformer cases. The secondary leads are run into the building through the usual service entrance conduit. H. S. KNOWLTON.

TRANSFORMERS LOCATED IN UNUSED CORNER OF FACTORY YARD

Save the Drops

ON PAGE 385 of the April 15 issue, this heading precedes some suggestions by N. G. Near, on a method of ascertaining the proper degree of lubrication of engine cylinders.

A Corliss engine, or other make having means provided for reversal or manipulation of the valves by hand, will tell the story of its needs in respect of oil, when the valves are thus operated. The degree of stiffness noted when reversing a few strokes affords a better criterion than the method set forth by Mr. Near.

H. K. SCHOLEFIELD.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Examination Questions and Answers for New York City Electrician's License

FOLLOWING is a list of questions asked in a recent examination by the New York Department of Gas, Water and Electricity for an Electrician's License. The answers are those given by a successful candidate.

1. How would you connect metal molding to a wooden outlet cabinet?

A. Use a cabinet lined with asbestos and 1/20 gage metal lining, securing the conduit electrically thereto by means of insulating nipples and locknuts.

2. How would you wire a gasoline storage vault?

A. Use metal conduit, wire with approved rubber and fireproof insulation and sockets inclosed in water and steam-tight globes. Fuse and switch cabinets should be dust and fire proof, provided with self-closing doors and placed on the outside walls of the vault.

3. What height would you place motors and other electrical equipment in a garage?

A. Not less than 4 ft. above the floor.

4. How would you reverse the direction of rotation of a single-phase motor equipped with starting base and running coils?

A. Reverse the starting leads.

5. How many and what type of switches would you use to wire the landing places of 4 flights of stairs?

A. Use 2 3-way and 2 4-way single-pole switches.

6. Where would you not employ a single-pole switch?

A. As a service switch, on outside arc and incandescent circuits, on the neutral of a 3-wire system, in damp places and circuits carrying a load of more than 660 w.

7. What precautions would you take in using metal moldings in which moisture would tend to collect?

A. Under such conditions use lead-covered or weatherproof wire.

8. How many sockets would you use on a circuit of outline lighting?

A. Thirty-two of the keyless type, the total load to be no more than 1320 w.

9. What kind of wire, conduit and sockets would you use in wiring a damp location?

A. Lead-covered wire, metal conduit, weather-proof sockets and water-tight globes.

10. What is meant by "voltage"?

A. This term refers to the number of volts ordinarily carried on a circuit, the potential difference across the terminals of a battery or generator, or the number of volts which may for safe operation be applied to any current consuming device.

11. Would you use a cord for wiring a show-case fixture?

A. No.

12. How would you connect fixtures in an old building when unable to use outlet plates or outlet boxes?

A. Connect to gas pipe by means of a combination joint; in case no gas pipe is available, use pipe and flange for support or secure by some other mechanical means.

13. How would you secure a bushing in the end of a fixture?

A. Screw bushing into fixture or hold by means of set screw provided for that purpose and make sure that the wire fills the bushing so as to avoid all undue strain on soldered joint. If the wire is too small, build up with insulating tape.

14. How would you wire a stage border?

A. By using no more than 32 keyless sockets mounted on insulating pedestals for each circuit and carrying no more than 4 wires in the case of a 2-wire direct-current circuit or 3 wires in the case of an alternating-current circuit in each conduit. The load per circuit should not exceed 1320 w. at a potential of 150 v., except with special permission.

15. How would you wire a call bell system using 110 v. alternating current?

A. Install a bell-ringing transformer using proper size of conduit and wire with approved insulation, protecting the system with fuses and grounding the conduit with No. 18 gage wire to water pipe and street side of the meter.

16. How would you determine the capacity of a link fuse?

A. This is generally found stamped on the copper ends of the fuse. For maximum capacity, consult a table of the carrying capacity of fuses and for minimum capacity use one of a size just sufficient to carry the power used.

17. What is a circuit breaker?

A. This is an automatic electrically operated knife switch which will open with an excess flow of a predetermined value of current. When the flow of current reaches a certain fixed value, a small trigger or dog, electrically operated, releases the switch, which, due to the action of a spring, flies open. A circuit breaker serves the combined function of knife switch and fuse.

18. What is a short circuit?

A. The term short circuit serves to indicate a condition whereby a circuit has been made between the 2 or more lines of a circuit "short," or ahead of the current consuming appliance.

19. If, when pulling out a switch you noticed an arcing heavier than ordinary, what trouble would you look for?

A. This may be due to a short circuit or a ground either in the circuit or the current-consuming device.

20. How would you wire a show case located on the sidewalk in front of a store?

A. Wire the case with No. 14 gage wire with the fuse, switch and plug inside of the store.

21. What special precautions are necessary when wiring breweries?

A. These ordinarily being damp places, rules for such should be adhered to and lead-covered wire used.

22. Where may lamp cords be used for voltages up to 250?

A. For drop lights in offices and similar places where not subject to rough usage. This cord must not be used in show windows or damp places.

(To be continued.)

Hoisting Engine Problem

I WOULD LIKE your advice regarding a pair of 20 by 36-in. first-motion hoisting engines, which are working on their foundations. The only noticeable movement is at or under the main pillow block bearings, which makes it impossible to keep the main bearings tight on the journals. What is the best way to stop this movement? I have been thinking of chopping the old grouting out and regrouting with sulphur. Would you recommend this?

Another idea I have is to set an extra anchor bolt in front of each main bearing, and make 2 brackets to be put on the bed plate by the use of cap screws about ⅞-in. in diameter, and bolt the brackets down with the extra anchor bolt. My reason for setting extra anchor bolts is because the engine foundation bolts have only about half a nut and will not allow much taking up.

Would the movement of the engine on its foundation have anything to do with causing the crankpin to come loose?

What effect, if any, would using a solid piston in the place of a cored piston have on the engine? We have a 20 by 20-in. high speed engine running 200 r.p.m. The original piston was built hollow, which together with several others, have broken from no apparent cause other than weakness. We are considering putting in a solid casting, which would, however, increase the weight by 200 lb. The original piston weighed 200 lb., so that a piston turned out of a solid casting will weigh approximately 400 lb. I would like to know what bad effects we could expect by the use of such a solid piston.—M. J.

ANSWERS

THE PROBLEM you are up against with your engines working loose on the foundation is a delicate one, to say the least, and one that is hard to prescribe for even with the information furnished. If one were permitted to view the situation after furnishing you with as full information as possible, one might find that he could complete the repairs better in some other way.

I will, however, suggest the best ways in which to go about the job and hope you will be able to carry out some of my suggestions with gratifying results. When an engine begins to work on its foundation, or even to "wink," as it is sometimes called in the earlier stages of the trouble, real trouble is at hand.

The fact that your foundation bolts have only half a nut on top is serious, as you are prevented from raising the entire engine an inch or so and regrouting it. and the chances are that the foundation bolts are grouted in solid—a useless proceeding. If they could be backed out an inch or 2, it would help considerably.

Another difficulty that presents itself in a case of this kind is that the engine gradually gets out of level and out of line and the longer the matter is put off the worse it becomes. To do a really first-class job, the pistons, connecting rods, and the crossheads (if necessary) should be removed and lines stretched through both sides and set accurately, and then check up the width between the lines at the cranks and back of the cylinders, with a steel tape laid on the edge of a stiff light board (to prevent sag). Or, if the tape is lacking, use the board alone, using a knife blade to scribe the location of the lines where first measured, and noting how this measurement checks up at the other end of the engine. If it is the same, then the 2 halves of the engine are parallel. Next, check up the leveling with a level known to be accurate, placing it in the cylinder, and in the bore of the slides. If the engine has bar or slipper guides, you will find that the maker has made some arrangements for leveling the frame lengthwise, either with "spots" planed on the frame, or on the lower guides themselves, but first make sure that they are not worn in the center. Check the shaft for level if a straight piece is convenient that will take the level, or drop a plumb line beside the wheel if it is known to run true. You may find that one side of the engine is lower than the other, although they may both be level and parallel.

The oil which has accumulated under the engine has assisted materially in loosening the bond between the engine and the foundation. To make a good job of cementing, you should have at least an inch of space between the engine and the foundation in which to grout. The foundation should be clean and free from oil. Use gasoline or a steam hose freely to take off the thickest of the oil, and chip off about an inch or so as you suggest, holding the engine on wedges and taking care to get well under the frame and other parts so that the cement will work up into the recesses under the castings.

Your idea of putting brackets on the frame and attaching them with ⅞-in. cap screws and putting down an extra anchor bolt is a good one. If the engine has a girder frame, make your straps liberal as to size and area. If you can secure a piece of steel large enough, heat it and form it to the frame so that it will fit snug and then put in several cap screws, using 1-in. instead of ⅞-in. screws.

Of course, you must previously drill the hole in the foundation to receive the new anchor bolt. Let the bolt be 1¼ in. in diameter or larger, drilling the hole, say, ½ in. larger than the bolt and about 3 to 4 ft. deep. Split the lower end of the bolt with the hacksaw about 6 in. and spread it with a chisel so that it will just enter the hole in the foundation. Having slipped the plate over the bolt, put in the capscrews and pour lead around the bolt. Such a job will hold indefinitely.

While sulphur has been and still is used to a certain extent, cement and sharp sand, mixed half-and-half thin enough to pour well, is used almost entirely, as it is procurable anywhere and is easily applied. Use a dam of light woodwork backed up with sand, or even bricks laid in lime mortar or laid dry and backed with sand or clay, in each case high enough so that you can fill in the cement about an inch higher than the bottom of the frame. Rowel it well with a light rod of iron, or a willow or hazel switch, so that it will enter all corners and work out the air and water.

Sulphur can be purchased through any dealer in power plant supplies, drug stores, or wholesale houses. It can easily be melted in a kettle and poured with a ladle or dipper, but take care and do not let it catch fire. It is not the pleasantest stuff to handle, owing to the odor. Sulphur will run into the smallest space and fill up the slightest crack, and its use is of advantage in the space between the engine and foundation if for any reason restricted.

You cannot have a decent running engine, to say nothing of a quiet running one, where the engine is loose on the foundation. Your main bearing trouble is directly traceable to this as well as your loose pins; but after regrouting your frame, do not expect your engine to run quiet as the bearing has probably worn spool shape and may be the babbit is pounded loose. Here is another big problem all by itself. Almost without exception, loose crankpins are directly traceable to a continued looseness some place about the engine, especially in the reciprocating parts, and when a shaft becomes loose on the main bearings or the frame on the foundation so as to work back and forth at every stroke, these parts in a sense become "reciprocating" parts.

The only way to cure a loose crankpin is to bore the hole and press in a new one turned a few thousandths of an inch larger. Leave an extended lip on the back of the pin so as to peen it over into a countersink on the inside of the hole.

Don't put a solid piston in your 20 by 20-in. high-speed engine, as you will take unto yourself a larger load of trouble than you now have with your broken pistons. When an engine is designed, it is calculated just what weight of counterbalance in the crank is necessary to balance the weight of the reciprocating parts. Through long practice and close observation of the engines in operation, most high-speed engine builders have worked out the problem of counterbalance to a nicety, so that even in engines of the same cylinder dimensions, operating at different speeds, the counterbalance is calculated according to the speed.

The early engine of slow speed usually had a crank in its simplest form, but, with the increase in speed, the disk crank with its concealed counterbalance came into being. So you can see that if you were to make a solid piston, you would increase the weight of the reciprocating parts by a large percentage, so much so that increased inertia of these parts could not be taken care of by the counterbalance, even if you adjusted the valve to give a little more compression.

If this trouble is continuous, as it seems to be, write the manufacturer of the engine to make you a piston of cast steel which is considerably stronger. If they cannot or will not do this, have them make you a new piston but have them line their corebox for the piston all around about ⅛ in. This is an easy matter. Engine builders change patterns continuously to meet certain conditions, and there is no reason why they should refuse to do it for you even at a slight cost, and the slight additional weight in the piston would not seriously offset the operation of the engine—certainly not nearly so much as a solid piston would.

A solid piston causes excessive wear on the cylinder of a horizontal engine. On a vertical engine it does not affect the wear but it certainly does affect the balance.

G. H. WALLACE.

Ventilating Fan Capacity; Commutator Trouble

IN THE plant where I am employed we have 2 ventilating fans one of which is 40 by 70 in. in diameter with 8 16 by 39-in. straight blades and the other 32 by 60 in. in diameter with 96 4 by 16-in. cupped blades. Both run at a speed of 150 r.p.m. How many cubic feet of air do these fans displace per minute?

2. A 550-v. direct current motor in my charge, after running a while throws a faint blue spark all around the commutator. What is the cause of this? How may it be remedied?

3. What is the meaning of the abbreviation K. V. A.?

C. J.

ANSWERS

IT IS impossible to give any simple or reliable rule for calculating the capacity of a fan from the dimensions of the fan wheel. There are 14 different variables which enter into determining the capacity, and when you change any one of them it has an effect on all the rest. The dimensions of the fan wheels are worked out by the manufacturers and designers, largely by trial.

From tables of fan capacities, the capacity of your straight blade fan will be 12,230 cu. ft. per minute. The cupped blade fan seems to be of unusual dimensions, as a fan 60 in. in diameter would ordinarily have blades 40 in. long, in the Sirocco type, and would have 64 blades.

As near as we can estimate from the capacity of a 60-in. Sirocco fan, your fan would have a capacity of about 12,000 cu. ft. a minute.

2. The kind of spark around the commutator of your motor would indicate that it is due to an open circuit in the armature, but the fact that it is a faint spark would also indicate that this is not a complete open circuit, or you would have rather vicious sparking.

It would seem likely that there may be so much friction between your commutator and brushes that these get hot after running a while, and thus raise the resistance of the contact between brushes and commutator, giving somewhat the effect of an open circuit. If this guess is right, you will find your brushes and commutator running hot.

3. K. V. A. on electrical machinery signifies "kilovolt-amperes." It is used on alternating-current machinery to distinguish from the kilowatts, which are found by multiplying the kilovolts by the amperes and by the power factor. If the machine were rated in kilowatts and were operating with a low power factor, when run up to rating as shown by the wattmeter, excessive current might be drawn, resulting in overloading of the armature.

A. L. R.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

How Can Leakage Be Stopped?

ON PAGE 471 of the May 15 issue, is a communication from D. C. H., under the above title. In answering this, I want to state that I had this same trouble on several stuffing-boxes constructed on the same order as described. I found this invariably to be due to the bore in the bottom of the stuffing-box being too large for the piston rod, allowing too much pressure to act on the packing, which pressure would not exist if the clearance between rod and bore was so close that the moisture contained in the steam would act as a seal.

To remedy the trouble, I have successfully used a ring, braided square from fine strands of annealed copper, cut to correct size and placed in the bottom of the stuffing-box, with the ends of the ring overlapping. This ring should be pressed home and then followed up with soft packing. The copper ring can be bought of any reputable packing firm. WM. SCHLIEMANN.

In regard to the trouble of D. C. H., mentioned on page 471 of May 15 issue, I would suggest that he center up his piston, as it is quite evident from his communication that it is low, causing the rod to run out of line. After the piston is centered he should check the rod for proper alinement by calipering in the stuffing box at both ends of the stroke, raising or lowering the rod at the crosshead as may be necessary to bring it into line. J. C. LONG, JR.

Diagram Criticism

MY CRITICISM of the cards sent by Indicator, appearing on page 471 of the May 15 issue, is as follows: I understand that the engine is provided with a shaft governor. The cards show that all of the events of the stroke are early when considering the area of the cards and from the shape of the expansion curve and compression line, I am of the opinion that both the piston and the valve leak. The admission is too early, as shown by the inclination of the admission lines.

I would advise an examination of the valve and its bushing, if one is provided; if not, then the valve seat, for leakage. Also test the piston for leakage, and if found defective, have them made tight.

As most shaft governor wheels are keyed to the shaft to insure their location, it might be necessary to make an offset key to bring the wheel in the proper location to have the admission when it should be, which is at the instant the crank passes the dead centers. Such position of the wheel being found by blocking the crosshead when the crank is on the dead center and with the indicator cocks on the same end of the cylinder where the piston is, open the throttle, turning the wheel on the shaft by hand until steam escapes from the indicator cock, when measurements can be taken for the key.

It would be well for Indicator to put the crank on the head end dead center, getting the lead right on that end first, and then if the adjustments are such that the valve cannot be equalized for both ends, as is often the case, he has done about all he can.

After making adjustments, Indicator should take the precaution to block out the governor weights in their extreme outward position and note that the port opening is not more than the lead if it opens at all to prevent the engine racing and "running away." RECEIVER.

Blowing Boiler Tubes with Air

MR. LEE ASKS what objection, if any, there is to blowing tubes with air instead of steam.

In reply, I wish to state that I followed this practice for about 2 yr., and discontinued it only because of shortage of air due to increasing the use of air in the mill. The reason why this method was instituted was this: The ¾-in. steam line back of the boilers from which steam was taken for the hand tube blowers was long, and, as a rule, was full of water from condensed steam when starting to blow the tubes. I tried to impress on the coal passers whose duty it was to blow the tubes that this water must be thoroughly blown out before starting to blow the tubes; but unless I was on hand to watch them this was seldom done, and considerable water was blown into the furnace. This not only checked the fire, but wet down the dust on the back tubes at 1 it could not be properly removed.

Therefore, a valve was placed in the steam line next to the header, and connections were made to the air pressure line carrying about 90 lb. air pressure. A valve was placed in this branch line which required only about 10 ft. of pipe. In this way, either steam or air could be used as desired. This, of course, eliminated the possibility of water being blown into the furnace. It is more expensive to use air than steam due to the unavoidable losses between the boiler and air compressor, and there are probably only a few plants in which this would be feasible. It has a tendency to lower the percentage of CO_2 during the time it is being used, but this is only for a short time each day unless the boilers are equipped with soot blowing device which is used several times a day as is the case in some plants. Air has the advantage that no water will be blown into the furnace which may cause the ashes to become baked into the tubes or chill the hot plates, the hose is cold and more easily handled without danger of burning the operator.

J. C. HAWKINS.

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Preparedness

In many of our cities the employes of isolated plants have an acute dread of and hatred for central station solicitors. This feeling is usually born of imagination as the result of ignorance of facts and conditions about their own plants. An isolated plant is installed by the owner as a matter of economy; so long as that economy is evident to the owner, it is unlikely that the central station will supply the plant with current. Few owners being engineers, it is often difficult to present reports of expenses and costs of different services which the plant renders to them in such a way that the true situation is comprehended.

The value of complete power plant records is frequently overlooked by owners, so much so that they refuse to supply the most necessary instruments for obtaining these records. This lack of appreciation on the part of the owner must be made up by the engineer who realizes only too well that his plant may be the scene of an investigation by central station engineers within a few years or when it becomes necessary to make changes requiring considerable expenditure of money.

To be prepared for this investigation means more than a knowledge of the machinery of the plant and how to operate it at highest efficiency; it means that the record of your entire force from chief engineer to coal passer must be maintained at a high average over a period of years; it means that the owner must be kept informed on the costs of the various services and perhaps educated in a general way on the proper methods of dividing costs of services; it means complete co-operation and fair play among all men of the force; it means, in many cases, that the chief engineer must personally supervise, instruct and even demonstrate to his men the methods of doing their work which have proved to be the most efficient; it means that each man must be given an incentive for doing his best; it means, above all, that a complete record of plant operation, outlines of which have been published many times in Practical Engineer, be kept accurately up to date, so that your arguments will have positive proof back of them. With such preparation the chief engineer of a plant can present facts to the owner with perfect confidence that the problem of central station service will be decided upon its merits rather than upon the statements and estimates of the central station solicitors only.

Editorial Comments

Mechanical handling of coal has reached a high degree of development and, as might be expected, several systems are in successful operation. The applicability of these overlaps somewhat and in some cases a combination of several systems proves most satisfactory. So diversified are the duties of coal and ashes-handling machinery, depending so directly upon local conditions, that nothing short of a thorough study of conditions surrounding the individual plant will enable an engineer to select the most desirable system for the plant.

Keeping this in mind, as you read the article of Mr. Edsall on the methods employed in the Victor Talking Machine Co.'s plant, you should note first the results to be obtained, then follow closely the descriptions of the details which make up the system; in this way one is

almost forced to appreciate the thoroughness with which this particular plant was designed and equipped. It is rare, indeed, that a power plant of this size is equipped with such an ideal system as this.

Aside from furnishing amusement and entertainment, the camera has another field which is just beginning to be developed. This is in industry for illustrating mechanical movements, too rapid for the eye to catch, so that the mind can analyze and comprehend the relative movements of parts. In the article on Illustrated Action of Valve Gear, the camera has been used to good advantage, giving the reader a clear idea of just what happens in the fraction of a second.

The bare statement of the elements and heat value of coal is of little or no value to a man who does not know the characteristics of the elements contained in the coal. Again, if we consider only the combustible elements of the coal, it is highly probable that our conclusions in regard to the value of the coal will be misleading. In this issue, Mr. Bailey interprets coal analyses with particular reference to the noncombustible constituents, and those who have had difficulty with clinkers will undoubtedly be helped by reading carefully what Mr. Bailey has to say in this article.

Losses are usually measured by the deductive process, i. e., you measure the input and output and the difference represents the loss. In the operation of steam boilers, there are several sources of losses, and to separate these is by no means a simple matter, but in the article on measuring blowoff water, we describe an inductive method of estimating this source of loss and by comparison from day to day this loss may be reduced to a minimum.

Did you realize the fuel value of shale? Here is a natural resource of our country which has not been developed and, according to the U. S. Geological Survey, as pointed out on another page, millions of gallons of crude oil await reclaiming. Is there no process by which this oil-containing shale can be used directly in furnaces? Possibly some inventive genius will show us the way.

Modern electric wiring means that the conductors are in conduit. To do the work in the best approved manner requires a knowledge of the electrical code and the fittings and other materials that are available on the market. It is with the intention of acquainting our readers with these appliances and methods that we publish the first of a series of articles by Terrell Croft on Rigid Conduit Wiring.

Wireless communication between power plants is a fact, as noted in an article in the Electrical Section, and it may become the duty of the engineer to keep this apparatus in working order. In our minds' eye we see future advertisements calling for chief engineers thoroughly familiar with wireless telegraphy as well as the whole category of machinery now common in power plants.

One of the necessities of today is lubricating oil; everybody knows that yet to apply oil properly and in sufficient quantity is not always so well recognized as pointed out by Mr. Parham in his article entitled Had Never Been Oiled.

What the other fellow is doing is always interesting to know, and when he is doing something in your own field or making investigations with machinery similar to your own, the information becomes more than interesting, it is usable and valuable. The articles by Mr. Blakey on foreign development are of the latter class, general in character but sufficient in detail for the engineer to make use of the ideas presented.

Being rather delicate in its operation, the gas producer has met with unjust criticism from those who have tried and failed to make it operate satisfactorily. Mr. Trautschold in this issue presents the second of a series of articles on Gas Producer Control, which we believe will tend to clear up a number of the difficulties encountered by operators.

The farther you advance, the more troubles you encounter; if you have been told of them before you reach them, you recognize them immediately and, being prepared, delay is slight. Mr. Scott gives some of his experiences with gas engines which may help you out of some trouble in a short time.

Why work for the Government? Well, why not? There are good reasons on both sides, and we publish in this issue a rather comprehensive article by A. P. Connor on the subject of Government Positions and how they are secured, which is of value not only to the man seeking government employment, but to everybody who takes an examination.

Letters direct from the plant, a lot of them, are published in this issue, and each is direct to the point with some usable idea well worth a home in a wrinkle of gray matter. Just look on the opposite page at the list of subjects treated and we know you will agree with us.

Another list of examination questions and answers appears in the Questions Department, this time for the electrician. There are other questions, well answered, which apply more directly to operating work.

The questions discussed in this issue bear directly upon the operation of a plant, and you should know what the other fellow did when these troubles were encountered.

Among the new apparatus described in this issue you will find a boiler meter that actually gets you somewhere, a true guide to the operation of the boiler.

Many have questioned the economy of turbine-driven centrifugal pumps, but the record we publish here of an actual test should leave little doubt and is worthy of note.

Peculiar operating conditions surround the steam ends of ammonia compressors, and the construction of a recently improved machine is described for your enlightenment.

Of course, you are preserving and using the Practical Reference Tables published once each month in Practical Engineer. In this issue we print some rapid calculating charts, the formulas for which are used every day in power plants. Try them out and see how much time you save. Other interesting and useful data are also given which will prove of value to you. If you have a formula, more or less complicated, which you use in your work about the plant, it is quite possible we can devise a rapid calculating chart to solve your problems quickly, or compile a table giving answers direct; at any rate, editors of Practical Engineer invite your correspondence in this regard for the benefit of yourself and the engineering profession.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Novel Boiler Meter

CONDITION of the fuel bed, rate of flow of air through the furnace, and rate of flow of steam output, are factors bearing directly upon the capacity and efficiency of a boiler. In the Bailey boiler meter, type D2, rate of air flow, fuel bed conditions, and rate of steam flow are combined and indicated on one chart; 3 separate instruments operate in the same casing. Steam flow is recorded near the center of chart with a blue pen, air flow is shown near the center with a red pen, and condition of the fuel bed is recorded near the outer edge of the chart with a blue pen.

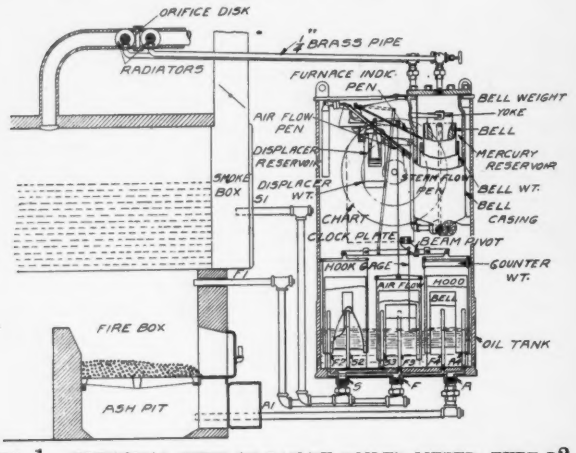


FIG. 1. SECTIONAL VIEW OF BAILEY BOILER METER, TYPE D2

Graduations upon the chart for recording steam flow are in per cent of the rated capacity of the boiler. The amount of steam equivalent to a boiler horsepower is based upon the average feed temperature, steam pressure, and moisture or superheat in the individual plant or boiler, and corresponds to a definite amount of steam per hour for each per cent of boiler output. An air flow reading on the chart is not a measure of the rate of flow in pounds or cubic feet per minute, but a measure of the rate of air supplied in terms of what it should be to correspond with the rate of steam flow, and is determined from actual tests on each individual boiler. Furnace indicator readings give a proper measure between drafts in ash pit, fire box, and smoke box, and resistance of the fire, which indicates the condition of the fuel bed.

Operation of the air flow meter is controlled by a bell, sealed with oil, having its lower end open. A hood over this bell forms an enclosure so that the smoke-box pressure is applied to the outside of the bell. Fire-box pressure is transmitted to the inside of the bell and thus the pressure drop across the boiler is effective over the cross-sectional area of the bell, tending to push it upward. By means of rods, a yoke, and a beam pivoted to the arm of the steam meter casing, the motion is transferred to the indicator pen. Counter weights, for balancing and adjusting, are placed on the beam, and also a special shaped displacing member is suspended by a pivot and submerged in mercury, which is drawn out as the beam rises to give a buoyant effect.

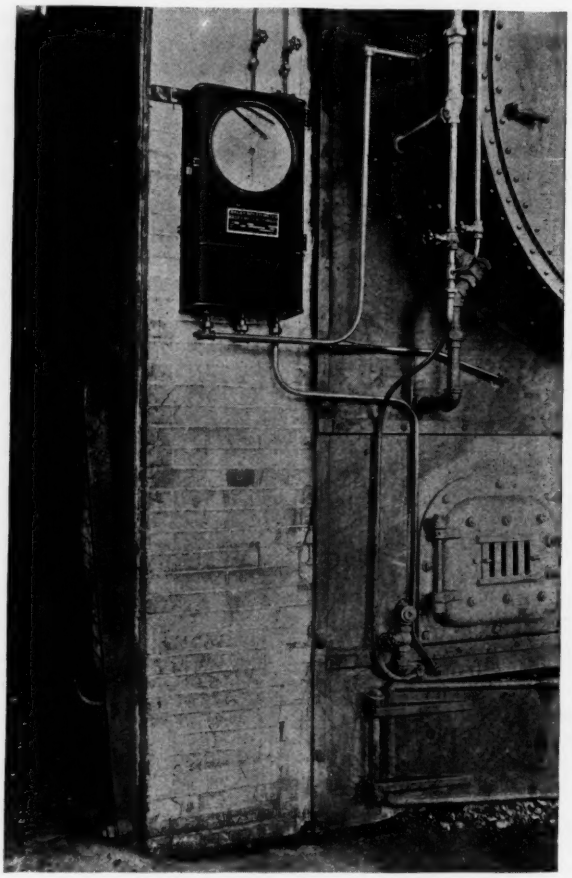


FIG. 2. BAILEY BOILER METER ON A RETURN TUBULAR BOILER

Combining the pressure drop across the fire and the pressure drop across the boiler so as to eliminate the effect due to the rate of flow of the air, and obtain a net result which varies with the resistance of the fuel bed, is the operating principle of the furnace indicator. This is accomplished by the use of 2 bells, one with a fixed area, the other with a variable area, and each covered with a hood. Each hood, by means of a yoke, is con-

nected to one end of a pivoted beam and motion is transferred from the beam to the indicator pen through a connecting rod and arm.

Ash-pit pressure is applied to the top of the fixed-area bell, and fire-box pressure is conducted to the inside. Any difference in pressure tends to pull down the end of the beam to which it is connected. In the variable-area bell, fire-box pressure is applied to the outside and smoke-box pressure to the inside of the bell, and the difference of pressure is effective over the area of the bell to the surface of the oil in the tank, and produces a downward pull on its end of the beam. While the desired relation exists between the resistance of the fuel bed and the resistance of the boiler, the 2 bells will balance each other, but should the fuel bed become too thick, the variable-area bell will be drawn up and present a larger area above the surface of the liquid. The motion of the bells in balancing is the measure of the change of resistance in the fuel bed, and is transmitted to the indicator pen by means of a connecting rod and arm.

On a similar principle the steam flow meter is operated, the difference between the static and dynamic pressures is effective upon the cross-sectional area of a mercury-sealed bell. These pressures are obtained from the steam line by a special designed orifice which is proportional to size of the pipe. Movement of the bell is transmitted to the steam flow indicator pen by means of a forked arm and pressure tight bearing.

The Bailey Boiler Meter is manufactured and installed by the Bailey Meter Co., of Boston, Mass.

Steam-Turbine-Driven Centrifugal Pump Makes Record

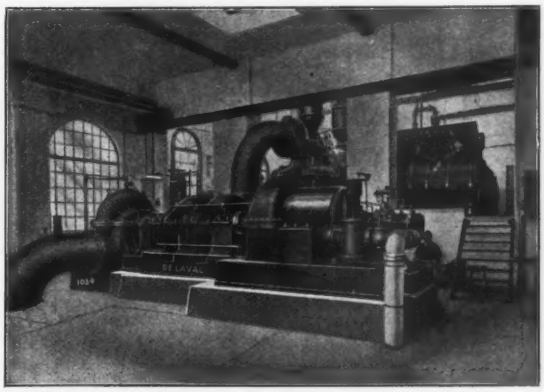
AN excellent record of duty for steam-turbine-driven centrifugal pumps has been established by a De Laval unit installed in the low level pumping station of the city of Montreal. This unit has a capacity of 30,000,000 imperial gal. per 24 hr., against 210 ft. head, and on test has developed the equivalent of 168,000,000 ft.-lb. per 1000 lb. of steam at 140 lb. gage pressure and 100 deg. F. (55.5 deg. C.) superheat, excluding friction head loss through condenser and piping.

The pumping equipment of the Montreal low level pumping station illustrates the progressive development of water works pumping units. The original installation, made in 1857, consisted of a water-turbine-driven pump. In 1868, a steam-driven auxiliary was added, since which the plant has grown steadily, so that it now contains 8 pumping units of a total capacity of 108,000,000 imperial gal. per 24 hr.

The head pumped against is 85 lb. per sq. in. plus 5 to 8 ft. suction lift. The main dimensions of the apparatus are as follows:

Brake hp. of turbine	1600
Number of stages	14
Speed of turbine, r.p.m.	3600
Ratio of gear	6 to 1
Diameter of suction and discharge openings of pump, both	30 in.
Speed of pump, r.p.m.	600
Efficiency of pump (guaranteed) not less than	80%
Weight of complete unit, including pump, turbine and gears	80,000 lb.
Floor space required, approximately	247 sq. ft.

The "water works" type of condenser, in which the water passes around the tubes and the steam through the tubes, is installed. It contains 3000 sq. ft. of surface and is served by a rotative dry vacuum pump. The condenser was estimated to weigh 36,000 lb. and the pump 7300 lb., and the 2 occupy a floor space of a little more than 100 sq. ft.



DE LAVAL GEARED STEAM-TURBINE-DRIVEN CENTRIFUGAL PUMPING UNIT IN MONTREAL PLANT

The following figures summarize the results of the final duty test:

Average water delivered per hr., Imperial gal.	1,308,808
Corresponding rate per 24 hr., Imperial gal.	31,411,292
Average pressure at gage on discharge pipe, ft. head	197.274
Average suction life from water level to center line of pump	8.6 ft.
Total average corrected head, ft.	205.874
Average water horsepower	1,360.85
Steam consumption, lb. per hr. corrected for heat returned in feed water	17,344
Average absolute steam pressure in lb. per sq. in.	159.7
Average actual steam temperature at engine throttle, deg. F.	426
Average superheat at turbine, deg. F.	63
Steam consumption per hr. corrected to contract conditions	16,638
Steam per water hp., lb.—actual	12.7
Duty per 1000 ft. lb. of steam supplied, in million foot pounds—actual	155.356
Duty per 1000 lb. of steam corrected to specified superheat and pressure, in million foot pounds	162.0

In calculating the above duties, the main unit was credited with an amount of steam equivalent to the heat returned to the boilers in the feed water. Part of this heat was obtained from a primary heater in the main exhaust connection and the remainder from an open heater which received the exhaust steam available.

During the test, readings of the suction and discharge pressures were taken at the suction and discharge nozzles of the pump, and the total head based upon these readings was found to be 213.86 ft. Calculated upon the basis of work actually delivered in the water as represented by the product of pressure by volume, the duty would therefore be as follows:

Duty per 1000 lb. of steam actually supplied, million foot pounds 161.4

Duty per 1000 lb. of steam corrected to specified superheat and pressure, million foot pounds.... 168.3

This is claimed to be the highest duty so far obtained by pumping units of this type, and falls little short of the best results obtained with triple-expansion pumping engines costing, including foundations and buildings, much more than the steam-turbine-driven centrifugal pump.

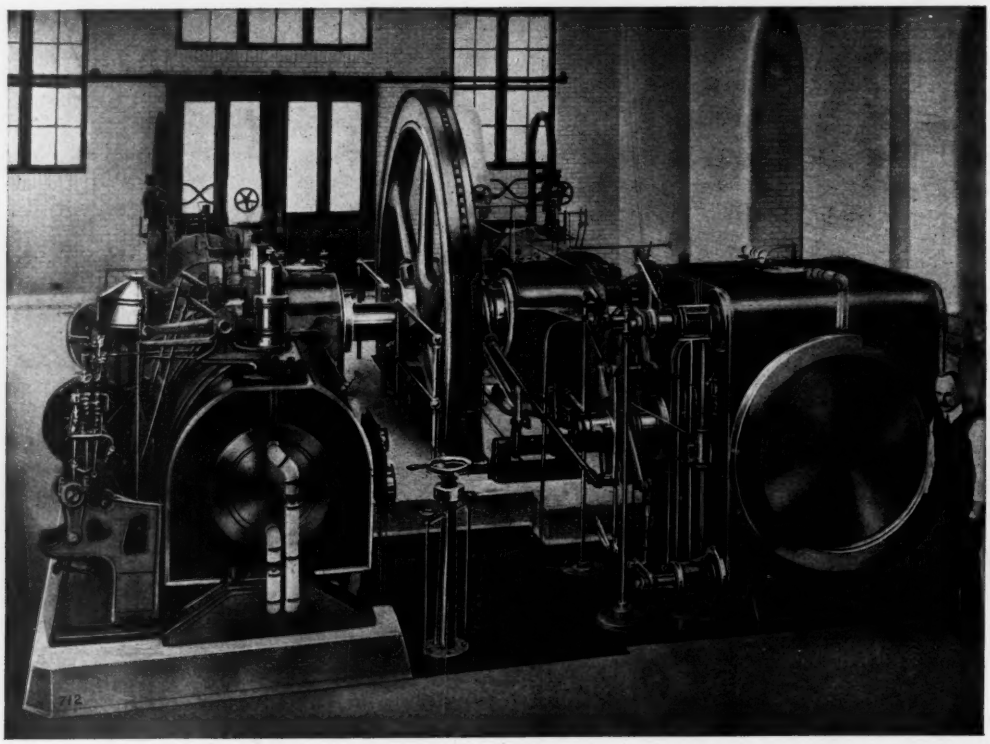
High Efficiency Steam Ends for Ammonia Compressors

IN recent installations of ammonia compressors, the question of steam economy has been given primary consideration. The use of high steam pressure and superheat is becoming common practice, calling for valves of the poppet type and refinement in cylinder and valve design to prevent distortion due to strains set up by the high temperatures. This applies to the high-pressure cylinder. The low-pressure cylinders are of the Corliss type, since the entering steam is at moderate pressures and temperatures.

The poppet high, Corliss low, steam end of an ammonia compressor recently installed at the Old Colony Breweries, Fall River, Mass., illustrated in the accompanying photograph, is one of high economy. The compressor was built by the De La Vergne Machine Co., New York, and the steam cylinders were built by the Nordberg Mfg. Co., Milwaukee, Wis., and conform in general to the designs for combined Poppet--Corliss compound engines which have been used recently for driving a constant load electrolytic generator at the U. S. Metals Refining Co., Grasselli, Ind., for driving a paper mill at the John Lang Paper Co., Philadelphia, Pa., and for many other ammonia compressors, including machines at the American Ice Co., Philadelphia, American Ice Co., Boston, and the Savannah Brewing Co.

Where the load is constant, or as in the case of ammonia compressors, the m.e.p. is constant, a compound engine can be designed for a single set of conditions and the highest economy can thereby be attained.

Referring to the photograph, the high-pressure cylinder is fitted with releasing type poppet valve gear with spring dashpots which are used for low and moderate speed machinery (40 to 100 revolutions) in order to insure sharp cutoff. The engine shown operates at a normal speed of 55 revolutions. The valves are of the double beat, balanced type, seating in separate removable cages, which are ground tight into the cylinders. Both the high and low-pressure cylinders are steam jacketed, the piping to the heads being shown in the picture.



NORDBERG POPPET-CORLISS COMPOUND STEAM CYLINDERS OF AMMONIA COMPRESSOR AT OLD COLONY BREWERIES, FALL RIVER, MASS.

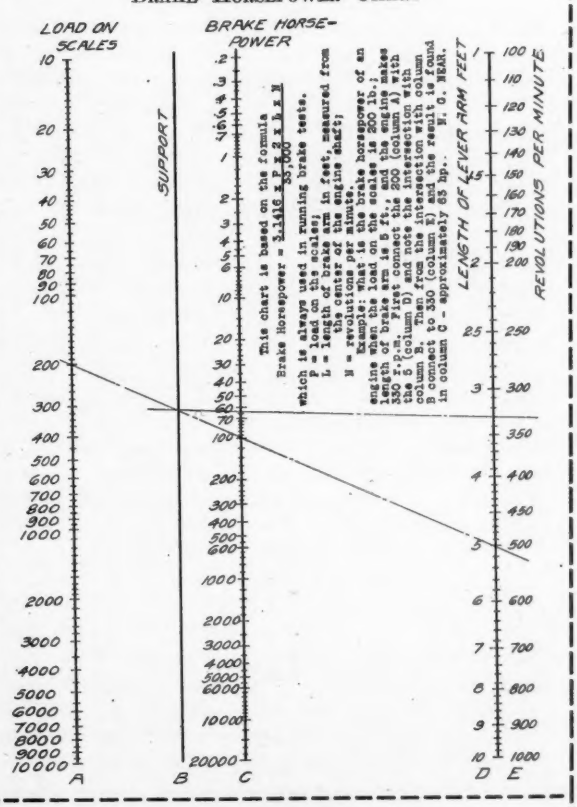
Between the high and low-pressure cylinders is a reheating receiver which dries and slightly superheats the

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

Brake Horsepower Chart


LOAD ON SCALES
BRAKE HORSE-POWER
SUPPORT
LENGTH OF LEVER ARM FEET
REVOLUTIONS PER MINUTE
This chart is based on the formula
Brake Horsepower = 2πLN x P
33,000
which is always used in running brake tests.
P = load on the scale;
L = length of brake arm in feet, measured from the center of the engine shaft;
N = revolutions per minute.
Example: What is the brake horsepower of an engine when the load on the scale is 200 lb.; length of brake arm is 5 ft., and the engine makes 330 r.p.m. First connect the 200 (column A) with the 5 (column D) and note the intersection with column B. From this intersection connect with column C and the 330 (column E) and the result is found in column C - approximately 65 hp.
W. G. MEAR.
A
B
C
D
E

PRACTICAL ENGINEER

Illumination Intensities Used in Shop Lighting

Kind of Shop or Work.	Foot-Candles.	Kind of Shop or Work.	Foot-Candles.
Bakery	2 to 3	Meat packing, cleaning	2 to 3
Bench work (fine)	5 to 10	Packing	2 to 4
(Rough)	3 to 5	Packing and shipping—	
Box factory	2 to 4	Fine work	2 to 5
Candy factory	2 to 4	Ordinary work	2 to 3
Clothing factory—		Paint shop, automobile	4 to 8
Sewing machine	10 to 15	Machine	2 to 5
Hand	4 to 8	Pottery, grinding	1 to 2
Cutting	5 to 6	Pressing	2 to 4
Cotton mill, weaving	2 to 4	Preserving plant,	
Dairy or milk depot	2 to 4	cleaning	2 to 4
Electrotyping	3 to 6	Cooking	2 to 3
Forge shop, ordinary		Printing, typesetters	6 to 8
anvil work	1 to 3	Presses	3 to 5
Tool forging	2 to 4	Sheet-metal shop,	
Foundry, bench molding	1 to 3	punching	3 to 6
Floor molding	1 to 2	Assembling	2 to 4
Glove factory, cutting	5 to 6	Shoe shops, cutting	5 to 7
Sorting	6 to 10	Bench work	2 to 5
Hat factory, forming	3 to 5	Silk mill—	
Stiffening	2 to 4	Winding forms	2 to 4
Blocking	4 to 6	Weaving	4 to 6
Jewelry making—		Finishing	3 to 5
Bench work	4 to 8	Stock rooms—	
Machine work	3 to 6	Rough material	1 to 3
Knitting mill	3 to 6	Fine material	2 to 4
Laundry	3 to 5	Wire drawing—	
Leather working, cutting	4 to 6	Coarse	2 to 4
Grading	6 to 8	Fine	4 to 8
Machine shop—		Fence machines	2 to 5
Lathes	4 to 7	Wood working, fine	3 to 5
Millers	3 to 6	Rough	2 to 4
Planer	3 to 5	Woolen mill—	
Drills	2 to 4	Picking table	2 to 4
Assembling	4 to 7	Twisting	2 to 3
		Weaving	4 to 6
		Warping	3 to 5

—Oliver R. Hogue.

Intensity in foot-candles is equal to the candlepower of the light divided by the square of the distance when light ray is normal to plane of illumination.

PRACTICAL ENGINEER

Gauges, Sheet Metal, Wire

No. of Gauge	Thickness in Decimals of an Inch: American or B. & S.	Brit. Imperial	Washburn & Moen*	Trenton Iron Co.	Stubs' Steel Wire	Am. Screw Co. Screw Wire	Am. S. & W. Co. Music Wire	Wash. & Moen Music Wire	Old English	French	Twist Drill
7-0		.500	.4900					.0087			
6-0		.464	.4615				.004	.0005			
5-0		.432	.4305	.45			.005	.010			
4-0	.46	.400	.3938	.40			.006	.011	.4540		
3-0	.40964	.372	.3625	.36		.0315	.007	.012	.4250		
2-0	.3648	.348	.3310	.33		.0447	.008	.0133	.3800		
0	.32486	.324	.3065	.305		.0578	.009	.0144	.3400		
1	.2893	.300	.2830	.285	.227	.0710	.010	.0156	.3000	.033	.228
2	.25763	.276	.2625	.265	.219	.0842	.011	.0166	.2840	.040	.221
3	.22942	.252	.2437	.245	.212	.0973	.012	.0178	.2590	.050	.213
4	.20431	.232	.2253	.225	.207	.1105	.013	.0188	.2380	.063	.209
5	.18194	.212	.2070	.205	.204	.1236	.014	.0202	.2200	.068	.206
6	.16202	.192	.1920	.190	.201	.1368	.016	.0215	.2030	.083	.204
7	.14428	.176	.1770	.175	.199	.1500	.018	.023	.1800	.097	.201
8	.12849	.160	.1620	.160	.197	.1631	.020	.0243	.1650	.110	.199
9	.11443	.144	.1483	.145	.194	.1763	.022	.0256	.1480	.120	.196
10	.10189	.128	.1350	.130	.191	.1894	.024	.027	.1340	.135	.194
11	.090742	.116	.1205	.1175	.188	.2026	.026	.0284	.1200	.149	.191
12	.080808	.104	.1055	.1050	.185	.2158	.029	.0296	.1090	.162	.189
13	.071961	.092	.0915	.0925	.182	.2289	.031	.0314	.0950	.172	.185
14	.064084	.080	.0800	.0800	.180	.2421	.033	.0326	.0830	.185	.182
15	.057068	.072	.0720	.0700	.178	.2552	.035	.0345	.0720	.197	.180
16	.05082	.064	.0625	.0610	.175	.2684	.037	.036	.0650	.212	.177
17	.045257	.056	.0540	.0525	.172	.2816	.039	.0377	.0580	.225	.173
18	.040303	.048	.0475	.0450	.168	.2947	.041	.0395	.0490	.238	.170
19	.03589	.040	.0410	.0400	.164	.3079	.043	.0414	.0400	.250	.166
20	.031961	.036	.0348	.0350	.161	.3210	.045	.0434	.0350	.263	.161
21	.028462	.032	.03175	.0310	.157	.3342	.047	.046	.0315	.279	.159
22	.025347	.028	.0286	.0280	.155	.3474	.049	.0483	.0295	.290	.157
23	.022571	.024	.0258	.0250	.153	.3605	.051	.051	.0270	.303	.154
24	.0201	.022	.0230	.0225	.151	.3737	.055	.055	.0250	.316	.153
25	.0179	.020	.0204	.0200	.148	.3868	.059	.0586	.0230	.331	.150
26	.01594	.018	.0181	.0180	.146	.4000	.063	.0626	.0285	.342	.147
27	.014195	.0164	.0173	.0170	.143	.4132	.067	.0658	.0188	.356	.144
28	.012641	.0149	.0162	.0160	.139	.4263	.071	.072	.0165	.371	.141
29	.011257	.0136	.0150	.0150	.134	.4395	.075	.076	.0155	.383	.136
30	.010025	.0124	.0140	.0140	.127	.4526	.080	.080	.0138	.394	.129
31	.008928	.0116	.0132	.0130	.120	.4658	.085		.0123	.406	.120
32	.00795	.0108	.0128	.0120	.115	.4790	.090		.0113	.419	.116
33	.00708	.0100	.0118	.0110	.112	.4921	.095		.0103	.431	.113
34	.006304	.0092	.0104	.0100	.110	.5053	.100		.0095	.448	.111
35	.005614	.0084	.0095	.0095	.108	.5184	.106		.0090	.458	.110
36	.005	.0076	.0090	.0090	.106	.5316	.112		.0075	.473	.107
37	.004453	.0068	.0085	.0085	.103	.5448	.118		.0065	.485	.104
38	.003965	.0060	.0080	.0080	.101	.5579	.124		.0058	.499	.102
39	.003531	.0052	.0075	.0075	.099	.5711	.130		.0050	.509	.100
40	.003144	.0048	.0070	.0070	.097	.5842	.138		.0045	.524	.098

*Known also as the Roebling gauge.

PRACTICAL ENGINEER

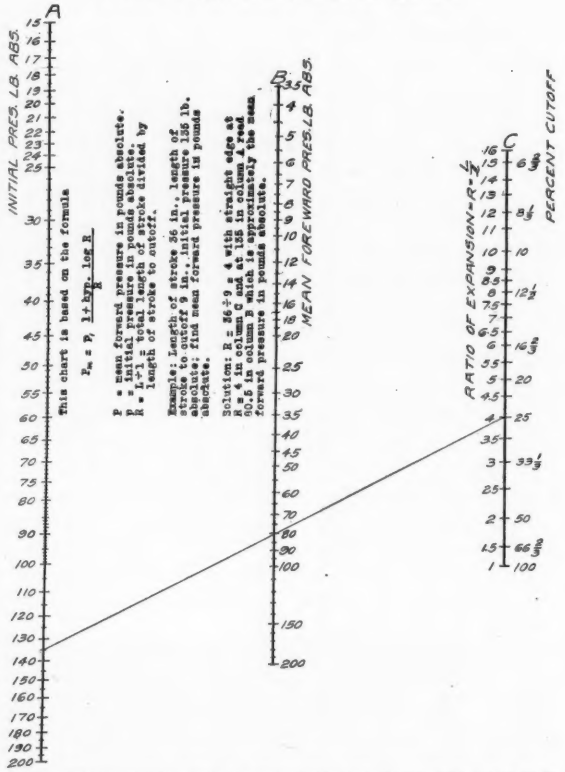
Standard Machine Screws

No. (Am. Screw Co. Screw Wire Gage)	Threads per inch	Diameter: Body	Diameter: Bottom Threads	Drills (Twist Drill Gage & Inches): Clearance: Close	Drills: Clearance: 1/32 Full	Tap
20	18	.3210	.2248	21/64	23/64	17/64
.....	16	11/32	.....	23/64	3/8	1/4
22	16	.3474	.2391	23/64	3/8	19/64
22	18	.3474	.2511	23/64	3/8	19/64
24	14	.3737	.2500	3/8	13/32	5/16
24	16	.3737	.2654	3/8	13/32	5/16
.....	16	3/8	.....	25/64	13/32	9/32
26	14	.4000	.2763	13/32	7/16	21/64
26	16	.4000	.2918	13/32	7/16	11/32
.....	16	13/32	.....	27/64	7/16	5/16
28	14	.4263	.3026	7/16	29/64	23/64
28	16	.4263	.3181	7/16	29/64	3/8
.....	16	7/16	.3181	29/64	15/32	11/32
30	14	.4526	.3289	29/64	31/64	25/64
30	16	.4526	.3444	29/64	31/64	25/64
.....	16	15/32	.....	31/64	1/2	3/8
.....	14	1/2	.....	33/64	17/32	25/64
.....	13	17/32	.....	35/64	9/16	27/64
.....	14	9/16	.....	37/64	19/32	29/64
.....	14	19/32	.....	39/64	5/8	1/2
.....	11	5/8	.....	41/64	21/32	1/2
.....	11	21/32	.....	43/64	11/16	17/32
.....	12	11/16	.....	45/64	23/32	37/64
.....	12	23/32	.....	47/64	3/4	39/64
.....	11	3/4	.....	49/64	25/32	5/8
.....	11	25/32	.....	51/64	13/16	21/32
.....	10	13/16	.....	53/64	27/32	43/64
.....	10	27/32	.....	55/64	7/8	45/64
.....	10	7/8	.....	57/64	29/32	47/64
.....	10	29/32	.....	59/64	15/16	49/64
.....	9	15/16	.....	61/64	31/32	25/32
.....	9	31/32	.....	63/64	1	13/16
.....	8	1	.....	.....	1 1/32	53/64

STANDARD MACHINE SCREWS

No. (Am. Screw Co. Screw Wire Gage)	Threads per inch	Diameter		Drills (Twist Drill Gage & Inches)		
		Body	Bottom Threads	Clearance Close	Clearance 1/32 Full	Tap
2	56	.0842	.0532	44	32	53
3	48	.0973	.0612	40	30	51
4	32	.1105	.0564	34	28	53
4	36	.1105	.0624	34	28	51
4	40	.1105	.0672	34	28	50
5	32	.1236	.0695	30	23	49
5	36	.1236	.0755	30	23	47
5	40	.1236	.0803	30	23	45
6	30	.1368	.0791	28	18	45
6	32	.1368	.0827	28	18	44
7	30	.1500	.0922	24	14	40
7	32	.1500	.0958	24	14	39
8	30	.1631	.1054	19	10	35
8	32	.1631	.1090	19	10	33
9	24	.1763	.1041	16	4	35
9	30	.1763	.1186	16	4	30
9	32	.1763	.1222	16	4	30
10	24	.1894	.1173	11	2	30
10	30	.1894	.1317	11	2	29
10	32	.1894	.1353	11	2	28
12	20	.2158	.1292	2	1/4	29
12	24	.2158	.1436	2	1/4	26
14	20	.2421	.1555	1/4	17/64	21
14	24	.2421	.1699	1/4	17/64	17
.....	18	1/4	.....	17/64	9/32	11/64
16	16	.2684	.1602	9/32	19/64	19
16	18	.2684	.1722	9/32	19/64	16
16	20	.2684	.1818	9/32	19/64	12
.....	18	9/32	.....	19/64	5/16	13/64
18	16	.2947	.1865	19/64	21/64	15/64
18	18	.2947	.1985	19/64	21/64	1/4
.....	18	5/16	.....	21/64	11/32	15/64
20	16	.3210	.2128	21/64	23/64	17/64

MEAN FORWARD PRESSURE CHART


A
INITIAL PRES. LB. ABS.
This chart is based on the formula
$P_m = P_i \frac{1+\log_e R}{R}$
P_m = mean forward pressure in pounds absolute.
P_i = initial pressure in pounds absolute.
R = ratio of expansion = length of stroke divided by length of stroke to cutoff.
Example: Length of stroke 36 in., length of stroke to cutoff 9 in., initial pressure 135 lb. absolute; find mean forward pressure in pounds absolute.
Solution: R = 36÷9 = 4 with straight edge at 4 in column C and at 135 in column A read 60.5 in column B which is approximately the mean forward pressure in pounds absolute.
B
MEAN FORWARD PRES. LB. ABS.
C
RATIO OF EXPANSION = R = L/l
PERCENT CUTOFF

STANDARD MACHINE SCREWS

No. (Am. Screw Co. Screw Wire Gage)	Threads per inch	Diameter		Drills (Twist Drill Gage & Inches)		
		Body	Bottom Threads	Clearance Close	Clearance 1/32 Full	Tap
.....	8	1 1/32	.....	.....	1 1/16	55/64
.....	8	1 1/16	.....	.....	1 3/32	57/64
.....	8	1 3/32	.....	.....	1 1/8	59/64
.....	8	1 1/8	.....	.....	1 5/32	61/64
.....	8	1 5/32	.....	.....	1 3/16	63/64
.....	8	1 3/16	.....	.....	1 7/32	1 1/16
.....	8	1 7/32	.....	.....	1 1/4	1 3/64
.....	7	1 1/4	.....	.....	1 9/32	1 3/64
.....	7	1 9/32	.....	.....	1 5/16	1 5/64
.....	7	1 5/16	.....	.....	1 11/32	1 7/64
.....	7	1 11/32	.....	.....	1 3/8	1 9/64
.....	6	1 3/8	.....	.....	1 13/32	1 1/8
.....	6	1 13/32	.....	.....	1 7/16	1 5/32
.....	6	1 7/16	.....	.....	1 15/32	1 3/16
.....	6	1 15/32	.....	.....	1 1/2	1 7/32
.....	6	1 1/2	.....	.....	1 17/32	1 17/64
.....	6	1 17/32	.....	.....	1 9/16	1 19/64
.....	6	1 9/16	.....	.....	1 19/32	1 21/64
.....	6	1 19/32	.....	.....	1 5/8	1 23/64
.....	5	1 5/8	.....	.....	1 21/32	1 21/64
.....	5	1 21/32	.....	.....	1 11/16	1 23/64
.....	5	1 11/16	.....	.....	1 23/32	1 25/64
.....	5	1 23/32	.....	.....	1 3/4	1 27/64
.....	5	1 3/4	.....	.....	1 25/32	1 29/64
.....	5	1 25/32	.....	.....	1 13/16	1 31/64
.....	5	1 13/16	.....	.....	1 27/32	1 33/64
.....	5	1 27/32	.....	.....	1 7/8	1 35/64
.....	5	1 7/8	.....	.....	1 29/32	1 37/64
.....	5	1 29/32	.....	.....	1 15/16	1 39/64
.....	5	1 15/16	.....	.....	1 31/32	1 41/64
.....	5	1 31/32	.....	.....	2	1 43/64
.....	4½	2	.....	.....	2 1/32	1 43/64

FOOT-CANDLES PER WATT PER SQUARE FOOT

Lighting Unit	Light Ceilings Light Walls	Light Ceilings Med'm Walls	Medium Ceilings Light Walls	Medium Ceilings Med'm Walls	Dark Ceiling Light Walls
Prismatic bowl reflector...	6.0	5.3	5.2	4.8	4.6
Steel bowl reflector.....	4.8	4.6	4.7	4.5	4.7
Dense opal glass reflector.	5.0	4.5	4.4	4.2	4.0
Light opal glass reflector.	4.8	4.3	4.2	3.8	3.5
Steel dome reflector.....	5.6	5.4	5.5	5.2	5.1
Totally indirect.....	3.3	3.0	2.3	2.0	1.2
Semi-indirect.....	3.8	3.4	2.8	2.4	1.6

This table is based on the use of approximately 1 watt per candlepower. Where a different efficiency is used, the value in this table should be divided by the efficiency at which the lamp is burnt.

RATIO OF HEIGHT OF LAMP TO SPACING

Ratio of Height to Spacing.	Type of Curve.
1 : 2	Extensive
5 : 8	Distributive
4 : 5	Intensive
4 : 3	Focusing
2 : 1	Concentrating

steam passing to the low-pressure cylinder. The latter cylinder is fitted with Corliss valve gear with separate eccentrics for the steam and exhaust valves. The valves are of the multiport type and are designed to present minimum valve clearance volume and surface in contact with the steam during the inlet and expansion periods so that the low-pressure cylinder has a high thermodynamic efficiency.

The steam end in this installation was guaranteed to operate with not to exceed 10.75 lb. of steam per i.hp. hour at normal load of 420 i.hp. with a pressure of 175 lb. per square inch, 150 deg. superheat at the throttle and a vacuum of 26 in.

A test was run on May 10, 1915, in which precautions were made to secure accurate readings of temperatures, pressures, vacuums and amount of condensate. Indicator cards were taken every 15 min. The condensate was measured by calibrated barrels and the corrections for condenser leakage was determined by a separate preliminary test. The observations show a steam consumption of 9.91 lb. per indicated horsepower under conditions of 174 lb. pressure, 175 deg. superheat, and 26¼ in. vacuum. The summary of the test, which was made by Louis Block, representing the Old Colony Breweries Co., and Mr. Green, representing the De La Vergne Machine Co., is given in the following table:

Average steam pressure	174 lb.
Average steam temperature	552.41 deg.
Average superheat	175.41 deg.
Average vacuum at machines	26¼ in.
Revolutions per minute	55.85
Average indicated horsepower	411.5 lb.
Total water per hour	4286.5 lb.
Condenser leakage per hour	211.5 lb.
Net water per hour	4075 lb.
Steam consumption, lb. per i.hp. hr	9.914

It is of interest to calculate the efficiency referred to the Rankine cycle. The heat per pound of steam corresponding to the initial conditions is 1293.2 B.t.u., and to the exhaust conditions after adiabatic expansion 957 B.t.u., making the heat theoretically available for conversion into work 336.2 B.t.u.

The B.t.u. corresponding to a horsepower is 2545, which, divided by 9.91, gives 256.8 B.t.u. as the heat actually turned into work per pound of steam. The efficiency is therefore 256.8 divided by 336.2, equals 76.4 per cent.

News Notes

INVITATION IS EXTENDED to all members of the N. A. S. E. throughout New England to attend the N. E. States convention to be held at Fall River, Mass., Thursday and Friday, July 13 and 14. The mechanical exhibition will be held in the State Armory, the sessions of the convention will be on Friday, and the smoker at 9:30 Friday evening. Sessions of the convention and the smoker will be open to all members of the association. It is hoped by the officers and the local committee that a large number, in addition to the regular delegates, will visit Fall River at this time.

THE METALS Production Equipment Co. has opened a western office, with E. E. Adams in charge, now located at room 530, First National Bank Bldg., Chicago.

AT THE CONCLUDING SESSION of the National Electric Light Association Convention held in Chicago, May 22-26, inclusive, the following officers were elected: H. A. Wagner, Baltimore, president; W. F. Wells, Brooklyn, R. S. Orr, Pittsburgh, R. H. Ballard, Los Angeles, and Alex. Dow, Detroit, vice-presidents; W. T. Aitkens, Boston, treasurer. New members of the Executive Committee are M. R. Bump, New York; M. J. Insull, Chicago; and W. H. Johnson, Philadelphia.

The Doherty gold medal was awarded to B. N. Blaisdell of the Manila section of the organization in consideration of his paper on "Power Plant Departments." To G. J. Leibman, Brooklyn, was awarded the Harriet Billings prize of $50 donated by Arthur Williams.

THE COLORADO SCHOOL OF MINES announces the following appointments, to take effect Sept. 1: George J. Young, now Professor of Mining Engineering, University of Minnesota, to the Professorship of Metallurgy; Claude C. Van Nuys, now Professor of Physics, South Dakota School of Mines, to the Professorship of Physics.

P. A. MOULTON, New York representative of The Sims Co., Erie, Pa., died suddenly, May 24, on a New York Central train at Tarrytown, N. Y., while enroute from New York to Albany.

Henry Sims, president of The Sims Co., is now in charge of the company's New York offices in the Marbridge Bldg., and will continue there until suitable arrangement can be made for new representation in its eastern territory.

LOUIS B. FULTON, late president of the Chaplin-Fulton Manufacturing Co., died recently at his home in Pittsburgh, Pa., in the seventy-fourth year of his age.

Mr. Fulton has been president of the company continuously since its organization as a corporation in 1891, and previous to that had been president of its predecessor, the Chaplin-Fulton Co., Limited, during the period of its existence.

Mr. Fulton was an accomplished mechanic and engineer, a fertile inventor and his genius and skill enabled him to take out many important patents.

About the year 1882, when the natural gas business was just entering upon its wonderful career, Mr. Fulton invented the famous Fulton gas regulator. It came just at the opportune time, and his ingenuity and painstaking application enabled him so to perfect it that it is known and used wherever natural gas is used.

It was stated by a distinguished engineer at a meeting of the Natural Gas Association of America, that Mr. Fulton was one of 3 men who by their inventions had made possible the practical use of natural gas.

Mr. Fulton was also an expert investigator of the laws of distribution of water and steam and had demonstrated his knowledge in all these lines by many inventions. He was often consulted informally by the managers of plants who valued his judgment, and it always delighted him to halt his own business when problems were detailed to him and gratuitously give his caller the benefit of his knowledge and experience.

Mr. Fulton was distinctly a self-made man. He began life as a poor boy apprenticed to a foundry, and by his own unaided efforts acquired a practical education and rose to a position of eminence as a mechanical engineer and manufacturer.

U. S. Civil Service Commission announces an examination for assistant sanitary engineer, on July 5, to fill a vacancy in the Public Health Service for duty in the field, at a salary of $1600, duties being to make studies of public health matters involving engineering problems, including stream pollution and sanitary surveys, the treatment of water, sewage and industrial wastes, and other similar subjects. Graduation from a college or university of recognized standing, with instruction including full courses in sanitary engineering, and at least 1 yr. of laboratory or field experience in some branch of sanitary engineering subsequent to graduation; or 5 yr. experience in sanitary engineering; or a combination of education and experience aggregating 5 yr., are prerequisites for consideration. Applicants must not have reached their forty-fifth birthday on the date of the examination, and must submit to the examiner their photographs, taken within 2 yr. Apply for Form 1312.

U. S. Civil Service Commission announces examinations, June 21, for Assistant Physicist (qualified in spectroscopy) in the Bureau of Standards, Department of Commerce, Washington, D. C., and Master Mechanic in the forge shop, Naval Gun Factory, Navy Yard, Washington, D. C. Apply for Form 1312, giving the title of the examination desired.

Book Reviews

Purchasing, by H. G. Twyford; 236 pages with charts, diagrams and forms; New York, 1915. Price, $3.

Scientific methods of purchasing supplies and raw materials have, in larger concerns, replaced the haphazard habits which but a few years ago prevailed almost everywhere. In this book, the author considers purchasing as a science based upon the source of supply, quality of materials, needs of the concern and sale price of the manufactured article. The subject is treated under 4 general headings, viz., Purchasing, The Purchasing Organization, Operation of Purchasing Department and Purchasing as Practiced. Each of these is divided into chapters which go into detail discussing such subjects as: the art of buying, personality in buying, influence of buying on profits, ethics of buying, the purchasing agent, organization of department, obtaining and tabulating proper records, etc. The book is not only intensely interesting to read, but presents the subject in such a way that it will be of direct aid to those having to buy materials in large or small quantities.

Principles of Depreciation, by Earl A. Saliers; 200 pages; New York, 1915. Price, $2.

Among the various subjects, other than those of a purely engineering nature, which the present day engineer must have at least some knowledge of, is depreciation. Without such knowledge and its application he is not in a position to determine the actual performance of his plant or do complete justice to the trust imposed in him.

While the material contained in this volume covers a somewhat greater field than that called for by the average stationary engineer, it should be of considerable value to consulting engineers, plant managers and superintendents, accountants and all others interested in the financial and mechanical problems of modern corporate enterprise.

The volume is divided into 3 logical sections, with an appendix, devoted to Theory, Practical Applications, and Determining the Depreciation Charges, respectively; the appendix is devoted to the theory and application of logarithms.

Among the subjects appearing under Theory are, Character of Industrial Plant, Analysis of a Hydroelectric Plant, The Plant Ledger, Depreciation Reserves vs. Depreciation Funds, and Depreciation and Efficiency. In Part II we find Regulation by Courts and Commissions, The Income Tax, Valuations, and Land in Valuations, while the subjects of Methods of Depreciation, The Straight Line Method, The Reducing Balance Method, The Sinking Fund Method, The Annuity Method, The Equal Annual Payment Method and The Unit Cost Method are discussed in Part III.

A special feature of this volume are the numerous forms, curves and graphical illustrations employed.

Practical Electrical Wiring, by John M. Sharp, 256 pages, 151 illustrations; New York, 1916. Price, $1.

No attempt is made in this volume, which is pocket size, to cover the entire field of electricity, but the principles of electrical installation are given, and sufficient detailed instructions are furnished to give the reader a practical understanding of wiring methods.

Importance of electrical wiring, wiremen's tools required and their uses, and the standard symbols used in wiring plans, are explained in the first chapter. Following chapters give information concerning wire joints, open and concealed wiring, and conduits.

Systems of distribution, and wiring for motors, telephones and bells are made clear with explanations and diagrams. Special wiring for remote control and switch suggestions are given. Wire tables, and other useful data are furnished and the book is well indexed.

The book should be of value to anyone having wiring problems. Practical methods are described in a clear and instructive manner.

Valves and Valve Gears, by F. DeR. Furman; 444 pages, 215 illustrations; first edition; New York, 1915. Price, $2.

This work, which has grown from a set of mimeographed notes, consists of 2 volumes, of which this is the second. The first of these volumes is devoted to the subject of valve gears as applied to steam engines and steam turbines, while this part of the work relates entirely to internal combustion engines, including those of the gas, gasoline and oil types.

In conformity with the method employed in Volume I to facilitate the use of the book as a text, it has been divided into many paragraphs which are consecutively numbered in each section.

The general subjects treated in the various sections are as follows: General Characteristics of Internal Combustion Engines, Commercial Applications of Various Forms of Valves and Valve Gears to Gasoline Engines, Aeroplane Engines, The Gas Engine, Oil Engines, Diesel Oil Engines and Comparison of Prime Movers.

UNDER THE TITLE of Condensing Equipment, the C. H. Wheeler Mfg. Co., of Phila, Pa., has issued a 180-page booklet containing 130 illustrations.

Discussion of the economy of high vacuum and the thermodynamics of condensers serves as an introduction to a discussion on jet, barometric and surface condensers, in which the factors and conditions for the efficient use of each type is taken into account. Vacuum pumps are divided into the 3 types, reciprocating, rotary displacement, and centrifugal entrainment, and the operating conditions to which each type is best adapted are brought out in detail. Illustrations are well used in showing the construction and operation of each style.

Feed water heaters; auxiliary engines, and exhaust connections are given full attention, and the subjects of water cooling towers and the spray cooling system are illustrated with views showing the design and arrangement of typical installations. Data regarding size and fittings for cooling ponds are also furnished.

AUTOMOBILE REPAIRING MADE EASY, by Victor W. Page, M.E., 1056 pages, 1000 illustrations, cloth binding; New York, 1916. Price, $3.

This comprehensive treatise on automobile repair practice covers the equipment required for this work, both for bench and floor operations, the process of overhauling, the gasoline engine, how to make different repairs, to set valves, clean and adjust carburetors, inspect and adjust oiling systems, the inspection and repair of the electric system for ignition, starting and lighting, tracing of faults in the transmission and their remedy, the overhauling of clutch mechanism and the care and repair of rear axles and differential systems.

It is a book well suited to the man engaged in repair work, or who has the care and is responsible for the upkeep of a gasoline-driven car. The illustrations are clear and complete, showing exactly how to go about different operations, giving a clear idea of the mechanism of the various standard and widely used cars.

Catalog Notes

FUEL BURNING REPORTS is the title of a publication just issued by the American Engineering Co. This booklet contains the results of 30 tests made upon boilers of various types equipped with Taylor stokers, the objects being either to secure high efficiency, high capacity, efficiency at stated load or to compare value of different coals.

SELF-EQUALIZING expansion joints of Badger quality are fully described in an attractive booklet issued by E. B. Badger & Sons Co., 75 Pitt St., Boston, Mass. Those who have problems in the expansion of piping of any size will be interested in this, as the joints are made for pipe from 1 in. up to 100 in. diameter.

IN A BOOKLET recently issued by the Department of the Interior, entitled "Glimpses of Our National Parks," the original purpose of which was to carry to children in the public schools a vivid idea of our own natural scenery, the descriptions have been made so full and complete, that it will have a more immediate mission. It is full of useful information for Americans of all ages, bringing together for the first time essential facts about all our national parks of which most people are not informed. The descriptions show that the United States is by far the greatest scenic country in the accessible world, give the distinguishing characteristic of each national park, and show, in a brief way, how pleasures which might be derived from a trip to Switzerland or the Canadian Rockies may all be enjoyed by visits to parks within our own borders. It shows, also, that here is a great national asset which has been overlooked, keeping in mind what Switzerland has accomplished with her exploitation of the Swiss Alps, and what Canada has done with Lake Louise. This book is a free government publication and can be had by writing to the Department of the Interior, Washington, D. C.

A 92-PAGE BOOKLET, of unusual interest, containing a large number of illustrations and charts relative to the installation and operation of soot cleaners, has been issued under the title of "Vulcan Soot Cleaners," by the Vulcan Soot Cleaner Co., of Du Bois, Pa. One section, in a discussion of what "soot" really is, points out in clear style the characteristics of the many forms of

soot. Reproductions in actual colors show various specimens of soot formed with hard and soft coal on different types of boiler and economizer tubes.

Mechanical details for installation with various types of boilers and comprehensive data based upon actual operating tests are given in describing the advantages of a mechanical soot cleaner.

DEPARTMENT OF THE INTERIOR, Bureau of Mines, announces the following new publications for distribution: Bulletin 86, some engineering problems of the Panama Canal in their relation to geology and topography, by Donald F. MacDonald. Bulletin 89, economic methods of utilizing Western lignites, by E. J. Babcock. Bulletin 114, the manufacture of gasoline and benzene-toluene from petroleum and other hydro-

carbons. Technical Paper 93, graphic studies of ultimate analyses of coals, by Oliver C. Ralston, with a preface by Horace C. Porter. Technical Paper 129, metal-mine accidents in the United States during the calendar year 1914, compiled by Albert H. Fay. Miners' Circular 20, how a miner can avoid some dangerous diseases, by A. J. Lanza and Joseph H. White.

THE LATEST general descriptive bulletin of Engberg's Electric & Mechanical Works, St. Joseph, Mich., was recently received.

NONPAREIL high pressure covering, is the title of an attractive booklet issued by the Armstrong Cork & Insulation Co., of Pittsburgh, Pa. Various methods for covering high pressure surfaces are illustrated in detail, and results are given of tests in which various materials and different thicknesses were used.

FROM HAUCK MFG. CO., 140 Livingston St., Brooklyn, N. Y., we have received Bulletin No. 65 dealing with Hauck burners and torches for brazing in boiler rooms, engine rooms and machine shops, burners for preheating in connection with welding, portable kerosene burners and other apparatus.

Trade Notes

THE CHAIN BELT CO., of Milwaukee, Wis., has recently introduced group insurance for its employes, under a plan by which each employe who has been with the concern 2 yr. or more is given a 1-yr. term policy for $1000, and those who have been employed 1 yr. and less than 2 yr., a policy for $500. This insurance is furnished to the employes without charge, and the amount of the policy in case of death will be paid direct to the beneficiary by the insurance company. It is the intention to renew insurance year after year, but changes in the method followed may be made as experience shows desirable.

FOLLOWING the recent order received by the Westinghouse Electric & Mfg. Co., for the equipment of the Inland Steel Co., the largest order for electrical equipment ever placed by a steel company, the Westinghouse Electric & Mfg. Co. announces the receipt of an order from the Phillips Sheet & Tin Plate Co., Weirton, W. Va. This contract calls for the complete electrical equipment of a new mill now in the process of erection by the Phillips Co., which manufactures sheet and tin plate, and produces cold rolled strips.

This company, a little more than a year ago, commenced the equipment of its mill with electric drive, and when the decision was made to erect a new mill, the same form of motive power was decided on.

The contract calls for 2 3000-kw., 3-phase, 60-cycle, 6600-v., turbo alternators; 1 1500-hp. constant speed alternating-current motor; 1 2500-hp. adjustable speed motor and 1 800-hp. adjustable speed motor. The speed adjustment of about 50 per cent from high speed is obtained on the 2500 and 800-hp. motors by means of direct-current synchronous control, a novel scheme devised and advocated by the Westinghouse engineers.

PRACTICAL ENGINEER
Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.
SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Full page, one year, each insertion, $60.00.

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Stippled plates used, but no heavy, black and white plates.

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No display type allowed, but the first three words may be set in capital letters.

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Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 5-15-2

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 5-15-3

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-5

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 6-15-1

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years' practical experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont, St., Portland, Ore. 5-15-2

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letters. Write to W. D. Bellesfield, Rock Valley, Iowa. 5-15-2

WANTED—Position as engineer in pumping station or in some stationary plant. I have had a 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 6-15-1

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 5-15-3

MANUFACTURERS' OPPORTUNITY to obtain the services of thoroughly A1 Engineer as Chief or Supt. of Power. A genuine offer of quality services, by a well experienced and technical trained man. This is not a bargain sale; it is a quality offering of established value. Investigation welcomed. Address Practical Engineer, Box 439, Chicago, Ill. 6-1-2

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents to handle Chemicals for Boiler Rooms, Laundries and the Automobile Trade. Strictly commission basis. State age and experience. Address Practical Engineer, Box 440, Chicago, Ill. 6-1-6

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—Steam Engine Indicator. Two cylinders and piston. Six springs. Reducing motion. Two cocks and carrying case. This instrument is good as new and will be sold subject to approval. Address Indicator, care Practical Engineer, Chicago, Ill. 6-15-2

FOR SALE—Second-Hand Machinery. One Hamilton-Corliss engine, 22x48, A1 condition. One 50-inch Fay-Egan band resaw and grinder. One 10-inch Fay-Egan 4-sided moulder. One 6-inch H. B. Smith 4-sided moulder. One Fay-Egan sash tenonner with double cope knives and cut-off saw. One 30-inch heavy cabinet planer (Whitney), with sectional feed rolls and sectional chip breaker. All above in first-class condition. The Vinton Company, Detroit, Mich. 6-15-2

FOR SALE—1 85-kw. Genera1 Elec., 3-phase, 4-wire, 110-220-volt, 60-cycle, belt-driven Generator and 2-panel Switchboard with 1 voltmeter, 3 ammeters, 7 quick break double-throw switches, exciter rheostat and 4-pt. test switch, all Wagner make. One 14¼x24 Buckeye Engine, 150 r.p.m., 125 hp. at 100 lb. pressure. Maximum hp. 165, with 63 ft. of 14-inch belt. All in good condition. Fine for small town plant. Will sell complete or separate. One 14x36 E. P. Allis Corliss Engine, 100 hp., 100 r.p.m., cylinder rebored, new piston and thoroughly overhauled one year ago. Good as new. Some 8-in. and 10-in. Lunkenheimer valves and 8-in. flanged L's and T's. Two 1¼-in. Crane tilt traps, almost new. Will sell above at a bargain. Dubuque Brewing & Malting Co., Dubuque, Iowa. tf.

TEN D. C. 220-VOLT MOTORS, 5 to 55 hp. Send for list. Lucas & Son, Bridgeport, Conn. 6-1-2

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Miscellaneous

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

ENGINEERS—Are you getting what you pay for in coal? Have it analyzed. Know exactly how many B.t.u.'s you get for one cent. Address Practical Engineer, Box 441, Chicago, Ill. 6-15-1

Sparks From The Advertising Pages

The Clearing House of Ideas

Before another issue goes to press, we will be "primed to the gills" with enthusiasm and information for and regarding the advertising convention to be held at Philadelphia June 25 to 30.

And why shouldn't we be?

It is the clearing house of ideas.

This heterogeneous mass of conventionites will represent most every industry on the map—even competitors will be fraternized, so wonderful is the power of this advertising convention.

The delegates will swarm around convention hall like bees around a sugar barrel. As usual, there will be advertising clinics for everybody. Each speech will be a scatter-shot of ideas—ideas that are the coinage of the brains of men vitally interested in business problems. The air will be thick with ideas, and thick indeed will be the brain-pan that will not absorb some of them.

A gigantic night pageant estimated to surpass that of the Chicago convention is scheduled for the evening of June 26.

Such inspirational speakers as Governor Brumbaugh, R. Goodwin Rhett, Cyrus H. K. Curtis, N. C. Kingsbury, Lewellyn E. Pratt are on the program, and President Wilson himself may speak at a glorious patriotic celebration before Independence Hall.

John H. Patterson of the National Cash Register Co., Dayton, has decided to send twenty-five men from his sales and advertising departments. He is convinced that the information and inspiration they will gain at Philadelphia will repay the company for the time and money the trip will cost.

But what has all this to do with you "stay-at-homes," you men who think you have nothing to do with advertising yet in reality cannot, to save your immortal soul, dissociate yourself from it. There are many advantages to be gained by you, but one of the concrete benefits is this: Those who attend the convention will get ideas that will make two sales where only one was before, and the widening of markets means a reduction in production costs and **in the selling price.** That's how you benefit, and on top of this there is tendency toward an increase in the quality of output.

Therefore, here is a convention that benefits producer and consumer.

If you are a producer, should you go? Well, do you hesitate stepping into the lunch room when your vitals are calling for victuals.—then why not make some effort to feed your mental faculties with this business-building food?

If you are a consumer, should you go? Well, if you want to see business history in the making—if you want to be mixed up with a brainy bunch of business men who have the natural faculty of passing along cashable ideas in a delectable manner and not in a cut and dried fashion, go to Philadelphia.

You'll do more good and get more good than at the three national political conventions where you spend a scad of money and waste a lot of energy for the mere sake of saying, "I've been there."